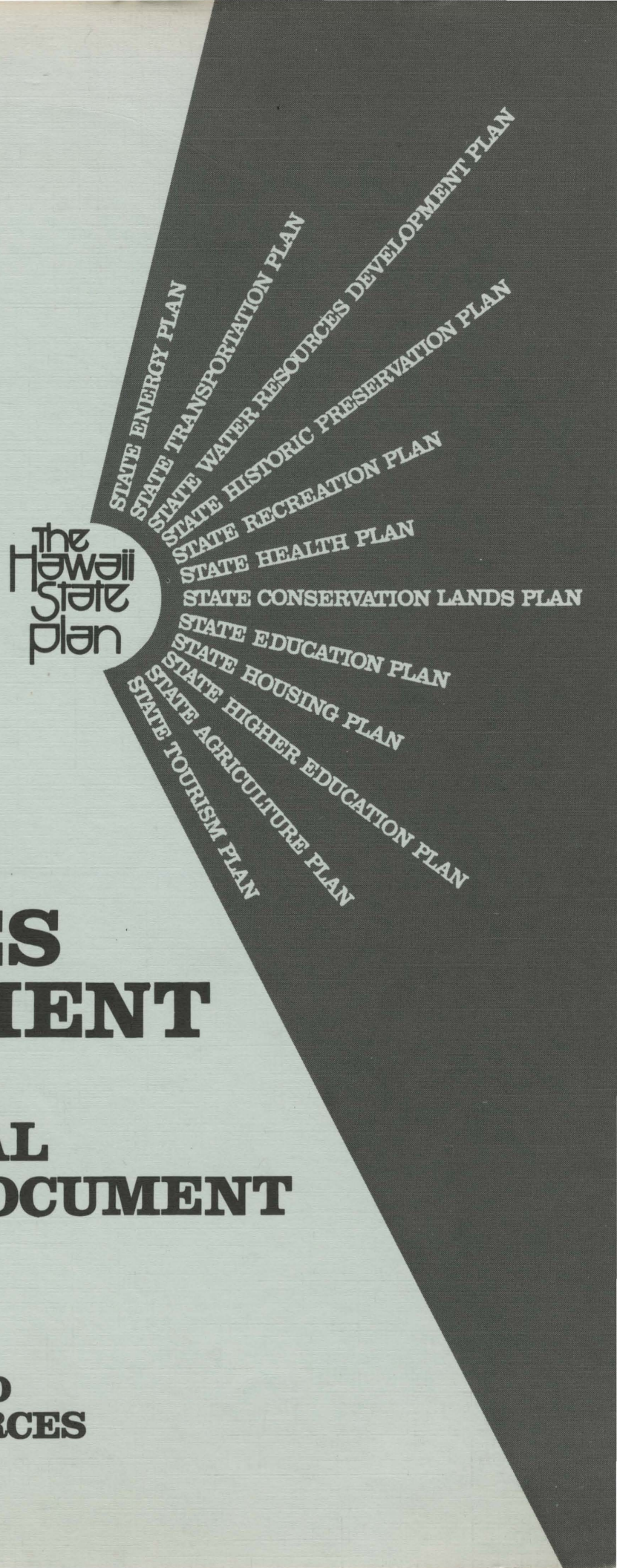
#4



STATE WATER RESOURCES DEVELOPMENT PLAN

AND TECHNICAL REFERENCE DOCUMENT

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE

WATER RESOURCES DEVELOPMENT PLAN

A State Functional Plan and Related Technical Reference Document
Prepared in Accordance With
Chapter 226, Hawaii Revised Statutes

Prepared by the

Department of Land and Natural Resources
State of Hawaii

Honolulu, Hawaii
September 1980

STATE OF HAWAII

George R. Ariyoshi
Governor

BOARD OF LAND AND NATURAL RESOURCES

Susumu Ono, Chairman

Moses W. Kealoha, Oahu Member

Stanley W. Hong, Member-At-Large

Roland Higashi, Hawaii Member

Thomas S. Yagi, Maui Member

Takeo Yamamoto, Kauai Member

DEPARTMENT OF LAND AND NATURAL RESOURCES

Susumu Ono, Chairman
Edgar A. Hamasu, Deputy to the Chairman

Robert T. Chuck, Manager-Chief Engineer
Division of Water and Land Development

FOREWORD

The Hawaii State Plan, Chapter 226 of the Hawaii Revised Statutes, outlines a long-range guide for Hawaii's future and establishes a statewide planning system. The system includes the formulation of 12 State functional plans, including this plan on water resources development.

The Department of Land and Natural Resources, charged with the responsibility of preparing the functional plan on water resources development, summarizes herein the results of its study to formulate a comprehensive plan for the development, utilization, and conservation of the water resources of the state. Aimed at implementing the goals, objectives, and policies of the Hawaii State Plan and county general plans, this Water Resources Development Functional Plan presents a balanced set of programs and projects to meet projected water resources requirements and management needs.

The Plan was prepared in concert with water-oriented public agencies and private entities, and public presentations of the preliminary plan were made to inform interested persons and organizations and to receive comments. A previous draft of the Plan was considered by the Tenth Legislature, State of Hawaii, Session of 1980. The Plan as presently drafted will be submitted to the Hawaii State Plan Policy Council for consideration and subsequent forwarding to the 1981 Session of the Legislature for adoption.

THE ADVISORY COMMITTEE

JOHN W. HOXIE, JR. (Chairman)
Field Department Head
McBryde Sugar Co., Ltd.
Eleele, Kauai, Hawaii

ROBERT T. CHUCK
Manager-Chief Engineer
Div. of Water & Land Development
Dept. of Land & Natural Resources
State of Hawaii
Honolulu, Hawaii

WILLIAM S. HAINES
Director
Department of Water Supply
County of Maui
Wailuku, Maui, Hawaii

KAZU HAYASHIDA
Manager and Chief Engineer
Board of Water Supply
City & County of Honolulu
Honolulu, Hawaii

HARDY IIDA
Chairman, Water Commission
County of Hawaii
Hilo, Hawaii

YUKIO KITAGAWA
Deputy to the Chairman
Department of Agriculture
State of Hawaii
Honolulu, Hawaii

MELVIN KOIZUMI
Deputy Director for Env. Health
Department of Health
State of Hawaii
Honolulu, Hawaii

DOROTHY LINDLEY
Executive Director
Hawaii Restaurant Association
Hawaii Society of CPA's
Honolulu, Hawaii

DEE LUM
Environmental/Energy Committee
League of Women Voters of Hawaii
Honolulu, Hawaii

WILLIAM PARIS, JR.
President, Palika Ranch
Kainaliu, Kona, Hawaii

RAYMOND SATO
Deputy Manager-Engineer
Department of Water
County of Kauai
Lihue, Kauai, Hawaii

PHIL SCOTT
Manager
East Maui Irrigation Co., Ltd.
Puunene, Maui, Hawaii

KIYOSHI TAKASAKI
Hydrologist
U.S. Geological Survey
Honolulu, Hawaii

ACKNOWLEDGMENTS

The State Department of Land and Natural Resources, as the preparing agency for the State functional plan on water resources development, has had the cooperation of many planning and water-oriented agencies at the Federal, State, and County levels of government; from private organizations; and from interested citizens. For this and the broad range of public participation incident to the preparation of this State Water Resources Development Plan, the Department is grateful.

It is particularly appreciative of the work of the Advisory Committee, without whose advice and guidance the Department would indeed have had difficulty in developing the Plan.

Finally, the Department acknowledges with gratitude the valuable services of its staff and the constructive comments received from outside water experts who reviewed the technical content of the document.

TABLE OF CONTENTS

TABLES

FIGURES

PART I

STATE WATER RESOURCES DEVELOPMENT PLAN

STATE WATER RESOURCES DEVELOPMENT PLAN

GENERAL PROVISIONS

The Hawaii State Planning Act, Chapter 226 of the Hawaii Revised Statutes, requires the preparation of functional plans in specified areas to implement the broad goals, objectives, policies, and priority directions contained in the Act. This functional plan on water resources development, prepared in accordance with the Act and designated the State Water Resources Development Plan, provides the critical middle link between the policies of the Hawaii State Plan and the concrete programs and actions carried out by the various State agencies.

Purpose and Scope. The purpose of the State Water Resources Development Plan is to set forth specific water-related objectives, policies, programs, and projects to guide State and County governments in implementing the broader objectives, policies, and priority directions of the Hawaii State Plan. By presenting such information, the State Water Resources Development Plan provides a basis for the wise allocation of resources to carry out various State programs in coordination with County activities.

In essence, the Plan presents guidelines for the:

(a) Development of water resources to meet municipal, agricultural, and industrial requirements, and the reduction of flood damage;

(b) Preservation of ecological, recreational, and aesthetic values and the quality of water resources; and

(c) Regulation of the use of water to assure adequate supplies for the future.

Plan Administration. The Department of Land and Natural Resources has been designated the functional plan agency responsible for administering and implementing the provisions of the State Water Resources Development Plan.

In consultation with its Advisory Committee for the Water Resources Development Plan, the Department will review and update the Plan at periodic intervals, as follows: (1) during the annual review and progress report to the Hawaii State Plan Policy Council and the Legislature on the implementation of the Water Resources Development Plan; (2) during the biennial review of the Hawaii State Plan Priority Directions; and (3) during the 4-year comprehensive review of the Hawaii State Plan.

Abbreviations. The following is a list of abbreviations of various organizations and agencies referred to in the Plan (Definitions of technical terms are listed in Part II, the Technical Reference Document):

DLNR	- Department of Land and Natural Resources
DOA	- Department of Agriculture
DOH	- Department of Health
DPED	- Department of Planning and Economic Development
LUC	- Land Use Commission
OEQC	- Office of Environmental Quality Control
SWCD	- Soil and Water Conservation Districts
UH	- University of Hawaii
WRRC	- Water Resources Research Center (University of Hawaii)

OBJECTIVES, POLICIES, AND IMPLEMENTING ACTIONS

The following are the objectives, policies, and implementing actions for the State Water Resources Development Plan:

OBJECTIVES, POLICIES AND IMPLEMENTING ACTIONS

MUNICIPAL WATER

Objective A. ASSURE ADEQUATE MUNICIPAL WATER SUPPLIES FOR PLANNED URBAN GROWTH.

Policy 1. Promote the development of new water supplies in support of planned urban growth.

Implementing Action (a). Implement, to the extent consistent with prevailing state fiscal policy, the municipal water projects and programs proposed by state and county water agencies concerned. (see Appendices A & B)

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Funding commensurate with projects selected
Priority Relative to Other
Implementing Actions: High

Policy 2. Continue to provide state grants and loans to the counties for municipal water projects and programs and provide for more equitable apportionment of such state grants and loans.

Implementing Action (a). Review current arrangements for state and federal assistance to the counties for municipal water projects and programs; improve policies to guide future grants and loans.

Lead Organization: DPED
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: $10,000
Priority Relative to Other
Implementing Actions: Medium

Objective B. SUPPORT LONG-RANGE MUNICIPAL WATER SUPPLY PLANNING BY THE COUNTIES.

Policy 1. Augment long-range county planning for municipal water supply development.

Implementing Action (a). Require the preparation of municipal water supply plans by the counties as a condition of future state financial assistance for county water programs and projects.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Consider appropriation of state funds for county water planning consistent with this State Functional Plan on Water Resources Development.

Lead Organization: Legislature
Assisting Organization: DPED
Time Frame: FY 1981-87
Budget Estimate: $40,000/FY
Priority Relative to Other
Implementing Actions: Medium

Objective C. PROMOTE MUNICIPAL WATER CONSERVATION.

Policy 1. Encourage the wise use and conservation of municipal water supplies through public education.

Implementing Action (a). Undertake a continuing public education program that stresses the full scope of water supply problems and the need to reduce per capita consumption.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Policy 2. Promote water conservation practices to the extent practicable.

Implementing Action (a). Establish a regular leakage control program for all municipal water systems.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: $40,000/FY
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Investigate restructuring of water rates to achieve water conservation.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: County Funded
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (c). Encourage the use of water-saving plumbing fixtures, and consider statutory or building code requirements for water-saving fixtures in new and renovated buildings.

Lead Organization: County Water Agencies
Assisting Organization: County Public Works Agencies
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Objective D. IMPROVE DRINKING WATER QUALITY.

Policy 1. Ensure a satisfactory level of drinking water quality throughout the state.

Implementing Action (a). Promulgate state drinking water standards no less stringent than those mandated under the Federal Safe Drinking Water Act, and provide for their adequate enforcement.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $20,000
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Adopt and implement a plan to provide safe drinking water under emergency conditions.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Enforce drinking water standards for all domestic water systems, public and private.

Implementing Action (a). Provide State financial assistance to counties for construction of treatment facilities needed to improve drinking water quality.

Lead Organization: Legislature
Assisting Organization: Dept. of Health
Time Frame: FY 1981-83
Budget Estimate: $4,500,000
Priority Relative to Other
Implementing Actions: High

Objective E. UPGRADE RURAL WATER SYSTEMS.

Policy 1. Upgrade rural domestic water systems to provide adequate supplies of potable water.

Implementing Action (a). Seek federal assistance for the upgrading of rural water systems through such programs as the Consolidated Farmers Home Administration Act of 1961 and the Rural Development Act of 1972, and the services of the Economic Development Administration of the U.S. Department of Commerce.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: (Federal Funds)
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Consider consolidation of rural water systems to achieve economy of scale in upgrading facilities.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Additional Funds Required
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (c). Appropriate funds to upgrade rural water systems where necessary to improve the quality of life.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other
Implementing Actions: Medium

WATER FOR AGRICULTURE

Objective F. IMPROVE THE QUALITY, EFFICIENCY, SERVICE, AND STORAGE CAPABILITIES OF SYSTEMS SUPPLYING AGRICULTURAL WATER.

Policy 1. Preserve water for existing beneficial agricultural uses and provide additional irrigation water where needed by further development of existing surface and ground water sources and improvements to diversion, storage, and transmission facilities.

Implementing Action (a). Preserve existing water sources, supplies, and facilities for continued beneficial agricultural uses of surface and ground water.

Lead Organization: Legislature
Assisting Organization: DLNR, DOA
Time Frame: FY 1981-87
Budget Estimate: None
Priority: Medium

Implementing Action (b). Provide funds to plan and construct irrigation water systems in support of agricultural parks, including in particular those located at Pahoa, Panaewa, Ke'ahole, and Lalamilo, on the island of Hawaii; Waimanalo, Waianae, and Kahuku on Oahu; Kula on Maui; and Kilauea on Kauai.

Lead Organization: Legislature
Assisting Organization: DLNR, DOA
Time Frame: FY 1981-87
Budget Estimate: $7,745,000 (See Appendix C)
Priority Relative to Other
Implementing Actions: High

Implementing Action (c). Evaluate the need for new, expanded, or improved State irrigation systems outside of agricultural parks, and develop as needed.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: FY 1981-87
Budget Estimate: Additional funds required beyond $8.2 million for agricultural park water systems development.
Priority Relative to Other Implementing Actions: High

Policy 2. Encourage close collaboration among agencies concerned with agricultural land planning and water development.

Implementing Action (a). Coordinate the activities of concerned federal, state, and county agencies to assure that agricultural water requirements and priorities are fully considered in planning and development decisions.

Lead Organization: DLNR
Assisting Organization: DPED, DOA
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: High

Implementing Action (b). Subsidize county municipal water systems serving agricultural water where there are no agricultural water systems.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Additional Funds Required
Priority Relative to Other Implementing Actions: Medium

Policy 3. Encourage the continued assessment of potential sources for development of agricultural water supplies.

Implementing Action (a). Continue to assess potential sources for development of agricultural water supplies, with particular emphasis upon sources suitably located for transmission of water by gravity flow to croplands.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Policy 4. Promote the increased efficiency in the storage, transmission, and application of irrigation water.

Implementing Action (a). Support directed research to increase watershed yields, reduce costs of pumping and storage, and perfect irrigation application methods.

Lead Organization: UH
Assisting Organization: DLNR, DOA
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Review reasonableness of rates charged for water sold under state water licenses.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: FY 1981-87
Budget Estimate: $35,000
Priority Relative to Other
Implementing Actions: Medium

Objective G. INCREASE THE USE OF TREATED SEWAGE EFFLUENT AND OTHER NONPOTABLE WATER FOR IRRIGATION PURPOSES.

Policy 1. Encourage siting of wastewater treatment plants so that effluent can be feasibly recycled for crop irrigation.

Implementing Action (a). Require that site planning for wastewater plants give consideration to the proximity of irrigated or irrigable cropland to permit the feasible reuse of effluent for irrigation purposes.

Lead Organization: County Depts. of Public Works
Assisting Organization: DOA, DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Provide appropriate incentives to encourage the use of treated wastewater for irrigation purposes.

Implementing Action (a). Consider property or excise tax incentives to irrigation water users who reuse wastewater.

Lead Organization: Taxation Dept.
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Low

Policy 3. Promote research to establish the economic feasibility and safety of reusing wastewater and other nonpotable water for irrigating crops such as sugarcane and forage.

Implementing Action (a). Support research to investigate the technical and economic feasibility of using wastewater or brackish water for irrigation applications notably those employing the drip method.

Lead Organization: UH
Assisting Organization: DLNR, DOA
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Promote the use of brackish water instead of fresh water for landscape and golf course irrigation and similar applications.

Lead Organization: DLNR
Assisting Organization: All Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Objective H. PROMOTE AGRICULTURAL WATER CONSERVATION.

Policy 1. Promote conservation of agricultural water to assure a safe and dependable water supply for all purposes.

Implementing Action (a). Develop cooperative programs with agricultural research agencies to explore and implement feasible conservation practices.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Consider incorporating water conservation provisions in all new state water licenses.

Lead Organization: DLNR
Assisting Organization: Attorney General
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Encourage activities to reduce or eliminate agricultural water losses, such as conversion to more efficient irrigation methods, and the rehabilitation of unlined, leaky ditches or substitution of closed pipelines.

Implementing Action (a). Require that approved conservation programs be a condition of state grants and loans for irrigation systems.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Require, where practicable, the use of more efficient irrigation methods in state-sponsored agricultural parks.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Objective I. PROVIDE ADEQUATE, REASONABLY PRICED WATER SUPPLIES FOR AGRICULTURAL PRODUCTION.

Policy 1. Encourage county municipal water systems to continue to charge lower rates for agricultural water consumers.

Implementing Action (a). Where the county municipal water system is the only alternative available for diversified crop irrigation, require the equitable accommodation of agricultural water needs as a condition of State grants and loans for municipal water projects.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Continue the public subsidy of irrigation water projects to enhance their feasibility.

Implementing Action (a). Maintain the present water rates charged by state-operated irrigation systems, or reduce rates where necessary to sustain economic diversified crop production.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: High

SELF-SUPPLIED INDUSTRIAL WATER

Objective J. REDUCE THE ENVIRONMENTAL IMPACT OF WASTE HEAT DISPOSAL FROM THERMOELECTRIC POWER PLANTS.

Policy 1. Promote research to develop more effective disposal of the large quantities of waste heat discharged from thermoelectric cooling systems.

Implementing Action (a). Encourage applied research to determine the effect of cooling water discharges on the Hawaiian ocean environment, including the potential of enhancing populations of aquatic life for sport or commercial fishery.

Lead Organization: UH
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Encourage studies of alternative sites for thermoelectric power plants and the potential effects upon the community and other land and water uses.

Implementing Action (a). Cooperate with efforts to investigate alternative sites for thermoelectric power plant sites statewide.

Lead Organization: DPED
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Objective K. DEVELOP WATER SOURCES FOR THE GENERATION OF HYDROELECTRIC POWER.

Policy 1. Encourage the continued assessment of sites well suited for commercial hydrolectric power plants, and encourage joint public and private financing of hydroelectric power development in Hawaii.

Implementing Action (a). Support programs for hydroelectric power development.

Lead Organization: DPED
Assisting Organization: DLNR, County Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Promote the integration of thermoelectric and hydroelectric power plants to improve efficiency.

Implementing Action (a). Collaborate with public utilities to assess and plan for the integration of new hydroelectric power plants with existing thermoelectric plants for increased efficiency.

Lead Organization: DPED
Assisting Organization: DLNR, County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

INSTREAM USES OF WATER

Objective L. ESTABLISH A PROGRAM FOR INSTREAM FLOW MANAGEMENT AND DEVELOP INSTREAM FLOW STANDARDS.

Policy 1. Promote the inventory of significant ecological, aesthetic, and recreation values for the development of instream flow standards.

Implementing Action (a). Designate a state agency responsible for data collection, inventory of instream values, and for the development of instream flow standards.

Lead Organization: Legislature
Assisting Organization: DLNR, DOH
Time Frame: FY 1981-82
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Compile and inventory all pertinent data for development of interim instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $70,000
Priority Relative to Other
Implementing Actions: High

Implementing Action (c). Develop interim instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $30,000
Priority Relative to Other
Implementing Actions: High

Policy 2. Promote the public interest in instream ecological, aesthetic, and recreation values, considering economic values.

Implementing Action (a). Take appropriate measures to protect and preserve unique ecosystem, waterfalls, scenic streams, rivers, lakes, and reservoirs.

Lead Organization: DLNR
Assisting Organization: DPED, County Water agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Provide and maintain, where appropriate, access for viewing and onsite enjoyment of scenic sites.

Lead Organization: DLNR
Assisting Organization: DPED, Counties
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Implementing Action (c). Develop instream flow standards, stream by stream, to protect ecological, aesthetic, and recreational values.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Implementing Action (d). Prepare draft legislation for instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $15,000
Priority Relative to Other Implementing Actions: Medium

WATER FOR AQUACULTURE

Objective M. DEVELOP WATER SUPPLIES FOR AQUACULTURE.

Policy 1. Encourage further assessment of sites well suited for commercial aquaculture and promote the planning and development of water supplies for such sites.

Implementing Action (a). Provide for aquaculture land use and water needs in state and county planning and development decisions.

Lead Organization: DLNR
Assisting Organization: County Planning Agencies
Time Frame: FY 1981-87
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Establish cooperative research programs to define water requirements for aquaculture.

Lead Organization: DLNR
Assisting Organization: UH
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Encourage cooperation between public planning agencies and private interests to insure that state support of aquaculture, including water development, is responsive to industry needs.

Implementing Action (a). Conduct studies to determine adequacy of water sources to support aquaculture at potential sites.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Investigate the feasibility of reclaiming livestock waste for aquaculture and recycling aquacultural wastewater for crop irrigation.

Lead Organization: DLNR
Assisting Organization: UH, DOA
Time Frame: FY 1981-87
Budget Estimate: $25,000/FY
Priority Relative to Other
Implementing Actions: Medium

Policy 3. Support research to determine water requirements for aquaculture and feasible disposal methods for aquacultural effluent.

Implementing Action (a). Provide for systems to effectively eliminate contamination and utilize wastewater from aquaculture farms.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other
Implementing Actions: Medium

WATER RESOURCES MANAGEMENT

Objective N. ENUNCIATE BASIC STATE WATER RESOURCES POLICY AND IMPROVE ADMINISTRATIVE FRAMEWORK.

Policy 1. Improve the administrative framework for water resources management by providing a sound legal basis for government management and regulation of water resources, while safeguarding private water rights.

Implementing Action (a). Authorize the formulation of a state water code aimed at defining the role of the state government in water resources management, specifying statutory language on water rights, and providing for an improved administrative structure.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: 3 years
Budget Estimate: $100,000 per year
Priority Relative to Other
Implementing Actions: High

Objective O. PROVIDE FOR WATER USE CONTROL.

Policy 1. Manage the water resources of the state for the most beneficial use by present and future generations.

Implementing Action (a). Implement the Ground Water Use Act when necessary to regulate the utilization of ground water sources in critical areas.

Lead Organization: DLNR
Assisting Organization: -
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: High

Policy 2. Assure equitable water use control of water sources for the good of the people.

Implementing Action (a). Institute a program to register all water source utilization in the state as an initial step in the assessment of water supplies presently and potentially available.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $40,000
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Enact legislation providing for the administrative regulation of all development and use of water resources in the state.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-83
Budget Estimate:
Priority Relative to Other
Implementing Actions: High

Objective P. MINIMIZE STORM WATER DAMAGE.

Policy 1. Reduce loss of life and property damage caused by storm flooding, tsunami, and high surf.

Implementing Action (a). Provide cost-effective structural measures such as dams, lined channels, and flood proofing.

Lead Organization: County Depts. of Public Works
Assisting Organization: DLNR, SWCD
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Control coastal development in areas subject to tsunami and high surf.

Lead Organization: DLNR
Assisting Organization: DPED, County Planning Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Enhance flood forecasting and monitoring.

Implementing Action (a). Enhance warning systems to detect storm conditions likely to cause flash flooding.

Lead Organization: County Civil Defense Agencies
Assisting Organization: -
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: Medium

Policy 3. Provide flood insurance protection to existing residences located in flood plains.

Implementing Action (a). Provide nonstructural measures such as flood plain and zoning regulations, building codes, and flood insurance.

Lead Organization: County Planning Agencies
Assisting Organization: DLNR, SWCD
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other
Implementing Actions: Medium

Policy 4. Intensify flood plain management activities to reduce future flood damage and to reduce future costs for protective measures.

Implementing Action (a). Promote educational programs.

Lead Organization: DLNR
Assisting Organization: SWCD, County Planning Agencies
Time Frame: Ongoing
Budget Estimate: $20,000/FY
Priority Relative to Other
Implementing Actions: Medium

Policy 5. Ensure the safety of dams to reduce downstream flood hazards.

Implementing Action (a). Determine dam safety hazards by field inspection and analysis, and take corrective action to minimize hazards.

Lead Organization: DLNR
Assisting Organization: Corps of Engineers
Time Frame: Ongoing
Budget Estimate: Additional Funds Required
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Prepare draft legislation to regulate the design, construction, maintenance, and operation of dams and reservoirs in Hawaii.

Lead Organization: DLNR
Assisting Organization: Corps of Engineers
Time Frame: FY 1981-87
Budget Estimate: $50,000
Priority Relative to Other Implementing Actions: Medium

Objective Q. PREVENT CONTAMINATION OF SOURCES OF WATER SUPPLY.

Policy 1. Manage surface drainage areas and ground water aquifers to prevent contamination of sources of water supply.

Implementing Action (a). Solicit federal funds for planning and construction of water treatment facilities to meet quality standards for drinking water.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: (Federal Funds)
Priority Relative to Other Implementing Actions: Medium

Implementing Action (b). Allow solid waste disposal only where leachates will not pose a hazard to existing or potential sources of potable ground water.

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: High

Implementing Action (c). Allow subsurface or injection well disposal of sewage or industrial wastes only where it will not pose a hazard to existing or potential sources of potable ground water.

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (d). Control well spacing and pumping to optimize development of sensitive basal aquifers.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: High

Implementing Action (e). Control use of high-chloride or or other poor quality irrigation water in areas overlying good quality ground water reservoirs.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Implementing Action (f). Support and help implement the erosion and sediment control measures of the State's "208" planning program relating to management of non-point source pollution.

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Encourage research to improve means of monitoring and testing water supplies to prevent contamination.

Implementing Action (a). Investigate water treatment and monitoring techniques that will minimize the cost of complying with state and federal drinking water standards.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Increase basal lens monitoring to prevent salt water intrusion.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/Fy
Priority Relative to Other
Implementing Actions: High

Objective R. ENHANCE MANAGEMENT OF WATERSHEDS.

Policy 1. Continue to manage state forest lands to protect and improve the condition of soils and vegetative cover so as to retard rapid runoff of storm flows, prevent soil erosion, and help sustain water yields of the quality and quantity needed.

Implementing Action (a). Conduct a systematic field survey of those state forest lands needing erosion control treatment.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: FY 1981-87
Budget Estimate: $20,000/FY
Priority Relative to Other Implementing Actions: High

Implementing Action (b). Install watershed rehabilitation measures to stabilize eroded areas, and to control erosion on roads and trails on state forest lands.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other Implementing Actions: High

Policy 2. Promote sound watershed protection and management practices in all forests in all land use districts, both publicly and privately owned.

Implementing Action (a). Continue to maintain close working relationships among agencies, organizations, and individuals concerned with the management, protection, and use of the State's watershed, and share research knowledge and expertise to promote sound watershed management practices.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other Implementing Actions: Medium

Policy 3. Carry out a continuing program of watershed management, rehabilitation, and protection, including the application of new methods and practices as they are developed and proven.

Implementing Action (a). Plan and carry out intensified rainfall-soil-vegetation surveys to provide basic information for resource protection and management and to determine whether present watershed boundaries need to be revised to better protect watersheds and water supplies.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: FY 1981-87
Budget Estimate: $20,000/FY
Priority Relative to Other Implementing Actions: Medium

WATER INFORMATION NEEDS

Objective S. EXPAND RESEARCH PROGRAMS.

Policy 1. Encourage research and monitoring programs for water data development for effective water resources planning and management.

Implementing Action (a). Continue to support the presently diversified water resource research effort (i.e., mission agency research and grant agency research).

Lead Organization: DLNR
Assisting Organization: UH
Time Frame: Ongoing
Budget Estimate: $30,000/FY
Priority Relative to Other Implementing Actions: Medium

Implementing Action (b). Develop a closer tie between planning and research in order to assure continued success and reinforce the value and relevance of each.

Lead Organization: DLNR
Assisting Organization: UH
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Medium

Objective T. IMPROVE DATA COLLECTION, ANALYSIS AND DISSEMINATION PROGRAM.

Policy 1. Encourage establishment of a good basic water data program by improvement of data collection, analysis and dissemination.

Implementing Action (a). Accelerate and improve programs for gathering information on water resources, including potential yields, water conservation opportunities, water demands, methods and costs of water development, and environmental impacts of development.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: High

Implementing Action (b). Improve means of putting available information to effective use in water management.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $20,000/FY
Priority Relative to Other
Implementing Actions: Medium

FINANCING WATER PROGRAMS & PROJECTS

Objective U. IMPROVE STATE GRANT AND LOAN PROCEDURES FOR WATER PROGRAMS AND PROJECTS.

Policy 1. Provide basis for orderly authorization and financing of water programs and projects.

Implementing Action (a). Utilize the policies and procedures of this Functional Plan to identify, set priorities for, and guide legislative funding for all meritorious water programs and projects.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). In providing State grants and loans to Counties, give priority to support of municipal water projects and systems designed and operated to accommodate agricultural, as well as residential, water uses and needs.

Lead Organization: DLNR
Assisting Organization: Counties
Time Frame: Ongoing
Budget Estimate: Additional funds required
Priority Relating to Other
Implementing Actions: High

Objective V. DEVELOP ADDITIONAL WATER FINANCING PROGRAMS.

Policy 1. Continue to determine alternative methods of financing future water resources developments.

Implementing Action (a). Explore the feasibility of purchasing bonds with state funds in order to reduce county borrowing costs and state grants for municipal water systems.

Assisting Organization: Dept. of Budget & Finance
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Low

Implementing Action (b). Explore cost-sharing between the state and counties as a means of encouraging selection of the more efficient water programs and projects and requiring beneficiaries to share in the costs.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Medium

Implementing Action (c). Require institution of appropriate water conservation programs by the counties as a condition of grants and loans for municipal water supply and wastewater facilities.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Medium

Implementing Action (d). Bolster applied water research in the state through long-term contributions from those state and county agencies that stand to benefit.

Lead Organization: WRRC
Assisting Organization: All Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Low

PART II

TECHNICAL REFERENCE DOCUMENT

CHAPTER I

INTRODUCTION

I. INTRODUCTION

The State of Hawaii possesses a wealth of water and related land resources. However, in recent years, the general public's interest in and concern over these resources has greatly intensified. Water demands have increased and become more diversified; new water uses have evolved; and problems associated with water supply, water recreation, flood management, environmental values, and the disposal of wastes have become more pressing with time and population growth. A statewide water plan is urgently needed as a management tool to guide the development, conservation, and administration of Hawaii's water and related land resources on a comprehensive and coordinated basis.

In 1975, the Hawaii State Legislature formally recognized the need to use Hawaii's limited resources wisely and called for the development of a comprehensive statewide plan to express the desired long-range future of Hawaii. After months of public opinion surveys, meetings and hearings, detailed analyses of issues and problems, and legislative deliberations, the Hawaii State Plan was formulated as the long-range guide to Hawaii's future. It was signed into law on May 22, 1978, and presently comprises Chapter 226 of the Hawaii Revised Statutes.

So that the goals and objectives of the Hawaii State Plan can be achieved and the many desired policies implemented, the authorizing legislation requires the preparation of functional plans covering particular subjects. These functional plans are intended to further detail the Hawaii State Plan, providing a critical middle link between the policies set forth in the Plan and the concrete programs and actions to be carried out by various government agencies. These functional plans are intended to:

(a) Provide a basis for the allocation of resources to carry out various state activities in conjunction with county activities.

(b) Guide agency activities in implementing State Plan goals and objectives.

(c) Identify major interrelationships among functional areas.

(d) Clarify state and county roles and responsibilities in the implementation of the State Plan.

Water resources development is one of twelve subjects required to be covered by a functional plan. The other subjects are agriculture, conservation lands, education, energy, health, higher education, historic preservation, housing, recreation, tourism, and transportation.

The Hawaii State Planning Act places emphasis not only on the content of the Hawaii State Plan itself, but also on the process of plan formulation. The Act requires that the state agency preparing a functional plan obtain input from the public, from its advisory committee, from the counties, and from the Policy Council.

The Advisory Committee established to guide and monitor the formulation of this Functional Plan includes members with a variety of interests from different segments of Hawaii's communities.

A. PURPOSE OF PLAN

The purpose of this Functional Plan on Water Resources Development is to provide flexible guidelines for the wise management of Hawaii's water resources in order to meet present and future needs and to improve the quality of life. Accordingly, this plan presents guidelines for:

--the development of water resources to meet municipal, agricultural, and industrial requirements, and the reduction of flood damage;

--the preservation and protection of ecological, recreational, and aesthetic values and the quality of water resources for present and future generations; and

--the regulation of the use of water to assure adequate supplies for the future.

B. SCOPE OF PLAN

The existing water situation is first discussed in this report; next, various water related needs and problems are analyzed; and action projects and programs to meet those needs are then recommended. Also, priorities for implementing actions are suggested.

C. PLAN REVISION AND UPDATING

While the Department of Land and Natural Resources has had the lead role in preparing of the Functional Plan for Water Resources Development, it has by no means had sole responsibility. Comments, recommendations, and draft sections of the Plan were invited and received from other State agencies, the respective County governments, industry organizations and individuals, and the general public. Formulation of the Plan was done in consultation with the Advisory Committee for the Water Resources Functional Plan, with the approval in principle of the Board of Land and Natural Resources. The plan as presently drafted represents a reworking and expansion of the version which was submitted to the 1980 Session of the Legislature.

The State Water Resources Development Plan should not be considered inflexible. It is made up of many implementing actions based on current objectives and policies for water resources development and on projections for future resource needs. As these objectives, policies, and needs change, the Plan should be updated to remain current.

The Plan will be reviewed by the functional plan agency, the Department of Land and Natural Resources, in consultation with the Advisory Committee for the Water Resources Functional Plan at periodic intervals, as follows: (1) during the annual review and progress report to the State Plan Policy Council and the Legislature on implementation of the Water Resources Development Plan; (2) during the biennial review of the State Plan Priority Directions; and (3) during the 4-year review of the Hawaii State Plan.

D. DEFINITIONS

Following is a glossary of terms pertinent to the subject matter of this report.

"Aquifer" means a saturated underground body of rock or similar material capable of storing water and transmitting it to wells or springs.

"Appurtenant water right" means a water use right initially pertaining to flow used for irrigation of taro land in cultivation at the time of the Great Mahele (year 1847) or for domestic use at that time.

"Available water supply" means the excess of sustainable yield from a water source over the current average rate of diversion or withdrawal from that source, including the estimated sustainable yield of an undeveloped or partially developed water source. (See "sustainable yield," "water development," "water source," and "water supply.")

"Beneficial use" of water means any utilization that is reasonable and consistent with the public interest, including the following two general categories: (1) any utilization of a developed water supply, such as but not limited to domestic, municipal, military, agricultural, or industrial uses, including the generation of hydroelectric power; and (2) any use of a water resource in place that does not substantially interfere with natural flow and diminish volume or quality, such as but not limited to navigation, recreation, aesthetic appreciation, and the sustenance of fish, wildlife, and other organisms. (See "domestic use," "surface water," "water resource," and "water supply.")

"Consumptive use" means water withdrawn from a supply which, because of absorption, transpiration, evaporation, or incorporation in a manufactured product, is not returned directly to a surface or ground water supply; hence, water which is lost for immediate further use. Also called "consumption."

"Cost effectiveness" means comparison of alternative ways to achieve a given objective in order to identify the least-cost way.

"Cost-sharing" is the assignment of the responsibility for paying the costs of a water project among two or more entities as, for example, among the federal government, a state government, and individual users.

"Desalting" is the technical process of converting sea water or brackish water to fresh water or otherwise more usable condition by removing dissolved solids. Also called "desalinization" and "desalination."

"Discharge" is the rate of flow of a spring, stream, well, canal, sewer, or conduit.

"Diversion." See "withdrawal."

"Domestic use" means any utilization of water to meet personal and household needs, including but not limited to: (1) drinking, bathing, laundering, cooking, and sanitation; (2) maintaining household pets; and (3) irrigating residential lawns and gardens.

"Ecology" is the study of the interrelationships of living organisms to one another and to their surroundings.

"Ecosystem" means a recognizable, relatively homogeneous unit, including contained organisms, their environment, and all of the interactions among them.

"Effluent" is the outflow of used water from a sewer, holding tank, industrial process, agricultural activity, etc.; sometimes treated, other times not.

"Evapotranspiration" means water dissipated to the atmosphere by evaporation from water surfaces and moist soil, and by plant transpiration.

"Flood plain" is the land area bordering a river, stream, or shoreline which is subject to flooding.

"gcd" means gallons per capita per day.

"Ground water" means water located underground in the zone of saturation that moves freely to points of discharge (springs) and withdrawal (wells and tunnels), including but not limited to water from artesian and non-artesian sources, impounded by dikes, perched on geologic strata of low permeability, or floating on and displacing salt water, as well as the subflow of streams and underground streams; but excluding wastewater. (Compare "surface water.")

"Headwaters" means the place where a river or stream originates.

"Individual domestic use" means domestic use of water from a privately developed source by a single household or relatively few households. (See "domestic use.")

"Instream use" is the use of water which does not require withdrawal or diversion from its natural watercourse. For example, the use of water for navigation, waste disposal, recreation, and support of fish and wildlife.

"mgd" means million gallons per day.

"Return flow" is the portion of withdrawn water that is not consumed by evapotranspiration and that returns instead to its source or to another body of water.

"Shortage" means an insufficient water supply for current beneficial uses. (See "beneficial use" and "water supply.")

"Surface water" means any water flowing or stored upon the inland surface of the earth, including but not limited to the water in rivers, streams, canals, ditches, lakes, ponds, marshes, reservoirs, and overland flows; but excluding wastewater and reclaimed water. (Compare "ground water.")

"Sustainable yield" means the water supply that may normally be diverted or withdrawn from a water source at the maximum rate which will not unduly impair source utility, including the estimated yield from an undeveloped or partially developed water source. (See "water source" and "water supply.")

"Tunnel" is a horizontal excavation into which ground water percolates, flows, or seeps from or to the interstices of the rocks or soil which it penetrates, and/or which is used to transport a water supply. (Compare "well," see "water supply.")

"Water development" means any method by which surface water is impounded within or diverted from its natural bed and banks or by which ground water is withdrawn from its source, and by which the resulting water supply is stored, transported, or treated in order to make it available for use. (See "ground water," "surface water," "water source," and "water supply.")

"Water resources" means all the ground water and surface water existing in its natural state within a particular area. (See "ground water" and "surface water.")

"Water source" means a place within or from which water is or may be developed, including but not limited to: (1) generally, an area such as a watershed defined by topographic boundaries, or a definitive ground water body; and (2) specifically, a particular stream, other surface water body, spring, tunnel, or well or related combination thereof. (See "ground water," "surface water," and "water development.")

"Water supply" means the water diverted or withdrawn from a water source, or that might feasibly be diverted or withdrawn from an undeveloped or partially developed water source. (See "water development" and "water source.")

"Well" means a drilled vertical or inclined shaft or vertical excavation into which ground water percolates, flows, or seeps from or to the interstices of the rocks or soil which it penetrates, and/or which is used to withdraw a water supply. (Compare "tunnel"; see "ground water" and "water supply.")

"Withdrawal" means the diversion and removal of water from a natural watercourse or ground water source, (also called "diversion").

CHAPTER II

RELATIONSHIP TO THE HAWAII STATE PLAN AND OTHER STATE AND COUNTY PLANS

II. RELATIONSHIP TO HAWAII STATE PLAN AND TO OTHER STATE AND COUNTY PLANS

Within its broad responsibility to enhance the general general welfare, the State has the more specific obligation to plan for and encourage the use of its resources in a manner that will best serve the physical, economic and social needs of the people.

The Hawaii State Plan enumerates statewide goals in the areas of the economy, the physical environment, and social well-being as follows:

(1) A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of needs and expectations of Hawaii's present and future generations;

(2) A desired physical environment, characterized by beauty, cleanliness, quite, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people; and

(3) Physical, social, and economic well-being, for individuals and families in Hawaii, that nourishes a sense of community responsibility, of caring, and participation in community life.

In order to understand the role of this Functional Plan on Water Resources Development within the context of the Hawaii State Plan, it is important to see the relationship among the distinct and separate planning documents that play a part in implementing the policies of the Hawaii State Plan.

A. RELATIONSHIP TO HAWAII STATE PLAN POLICIES

Functional plans are intended to elaborate upon the pertinent broad policy statements contained in the Hawaii State Plan. Because certain policy statements of the Hawaii State Plan may relate to more than one of the designated

functional areas, the objectives and policies applicable to a particular functional area must be identified. Table 1 summarizes the relationship of this Functional Plan of Water Resources Development to the objectives and policies of the Hawaii State Plan.

B. RELATIONSHIP TO HAWAII STATE PLAN PRIORITY DIRECTIONS

The Hawaii State Plan Priority Directions consists of actions and policies that address current State wide concerns. These actions and policies focus on eight thematic areas, all of high priority:

- Theme 1: Provide jobs; stabilize and diversify Hawaii's economy.
- Theme 2: Maintain a healthy visitor industry.
- Theme 3: Protect and encourage agricultural activities.
- Theme 4: Encourage increased public and private investment in the Neighbor Islands.
- Theme 5: Conserve water and energy resources, and increase research and development of alternative sources of water and energy.
- Theme 6: Manage population growth so that it does not threaten Hawaii's basic resources.
- Theme 7: Direct growth to existing urban areas or to lands adjacent to such areas.
- Theme 8: Protect areas of environmental or social significance from urban development.

These interrelated topic areas, when considered together, provide a composite picture of what the Legislature and Governor feel are most important and should be the focus of action.

Of primary importance is a stable and diversified economy--one that can provide the quality and number of jobs needed by Hawaii's people. The Governor and the Legislature recognize that the visitor industry will continue to be a major employment base in Hawaii's economy. It is presently the State's largest industry and the largest source of jobs. It appears to be the only major industry that can provide needed additional jobs in the short term. The policy makers also recognize, however, that an economy heavily dependent on tourism is quite vulnerable to recession. By depending heavily on a single industry, Hawaii takes the risk of possible widespread unemployment and business recession during difficult times. For this reason, emphasis is also placed on diversifying the State's economy. These diversification actions will not provide quick results, but determined effort is needed now if new major industries are to be developed to pick up the State's economy in the future, and allow for a gradual lessening of the dependence on tourism.

Strengthening agriculture has been identified in Priority Directions as one of the primary ways of diversifying the economy. This is due to diversified agriculture's potential for expansion, and equally important because of the prominent social and environmental values agriculture provides to our Island communities. Agricultural activities, like papaya farming, flower raising, coffee growing and vegetable production, all have good potential for growth throughout the Islands, particularly on the Neighbor Islands. Closely related to agricultural diversification is aquaculture, which shows considerable promise for Hawaii.

One of the primary reasons for the emphasis on a stable economy is the need to reasonably manage the State's population growth. It has become quite clear that the State's population should not be allowed to grow at the rates of the past. The Governor and the Legislature, through Priority Directions, have also deemed it important that the "pace and place" of

growth be consistent with the State's resources. This demands, of course, an understanding of Hawaii's resources and how to develop the special tools needed to help manage growth. The desired economy is one that maintains a preferred rate of growth--the rate needed to provide jobs for Hawaii's people, and to avoid periods of boom or bust.

The success of new investments is dependent upon the availability of essential resources within the State. But many of these resources are limited in quantity. The danger that sources of water and energy may soon be depleted is an immediate concern. Therefore, efforts to conserve current supplies and to develop alternative sources of water and energy must be intensified.

Finally, although they expect the rate of population growth to be modified through sound planning, the Governor and the Legislature also know that the population will nevertheless continue to grow and development continue to occur. They, therefore, have focused part of their priority emphasis on how and where this growth might occur. Due to the potential resources problems on Oahu, and also to the need for increased job opportunities on the Neighbor Islands, Priority Directions clearly calls for the Neighbor Islands to absorb a larger share of futre growth. Oahu should continue to absorb the most growth in absolute numbers, but a larger propoportion of the total Statewide growth can be expected on the Neighbor Islands.

It is also considered important that any new development be directed--as much as possible--to existing urban areas or lands adjacent. Many urban areas have vacant lands or underdeveloped locations. By directing urban development here first, existing resources and facilities can be used more efficiently. Reducing scattering of urban developments will also protect many areas of environmental and social importance, such as shorelines, agricultural lands, wetlands, and communities whose residents prefer rural or unique lifestyles. This is not to say

that urban developments will never be scattered or that the development of sensitive areas will never take place. It is to say, however, that the Governor and the Legislature put considerable priority on both these areas, and that programs relating to physical planning decisions should give these ideas priority consideration.

Specific Priority Directions relating to the Water Resources Development functional plan are the following:

- Assist in providing adequate, reasonably priced water for agricultural activities.
- Seek federal assistance to increase water supply and to improve transmission, storage, and irrigation facilities to promote diversified agriculture and aquaculture.
- Encourage water conservation to reduce the per capita water consumption rate through education and the promotion of conservation awareness.
- Assist agriculture in determining the feasibility of using wastewater effluent to irrigate crops.
- Pursue the improvement of irrigation technology to increase the effective and efficient use of water.
- Increase the support for research and development of alternative water sources.
- Encourage the development of alternate energy sources.
- Plan the development and availability of land and water resources in a coordinated manner so as to provide for the desired levels of growth in each geographical area.
- In order to preserve green belts, give priority to state capital expenditures that encourage locating urban development within existing urban areas in accordance with the following: funding for transportation activities that serve the needs of existing urban areas; allocation of water for urban uses to areas within urban areas; and wherever possible, locate state buildings and facilities within urban centers close to public transportation; except where compelling public interest dictates development of a non-contiguous new urban core.

- Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats (on land and in the ocean); areas with endangered species of scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources.

- Encourage restriction of new urban development in areas where water supply is insufficient for both agricultural and domestic uses.

- Coordinate planning for wastewater and solid waste disposal with state and county growth objectives.

C. RELATIONSHIP TO OTHER FUNCTIONAL PLANS

In order for the Hawaii State Plan to work properly, it is important that related Functional Plans be intergrated and give attention to the concerns of other functional areas. An effort has been made to identify in a general way potential areas of agreement and conflict in carrying out the activities of the Water Resource Development Plan.

Water resources development activities relate in some fashion to all the other functional areas. Some relationships are physical development-related, such as the construction of a large reservoir in private agricultural land. Others are more program-related, such as the establishment of instream flow standards. Primary interrelationships exist with agriculture, tourism, environmental health, and housing, and to a lesser degree with conservation lands, recreation, transportation, education, energy, and historic preservation.

Major areas of impact between water resources development and other functional areas are identified below. Also, Table 2 indicates the general nature of the relationship between the Water Resources Development Plan and other functional plans.

Agriculture:

(a) Water development for agricultural uses relative to development for other uses.
(b) Financial subsidy for irrigation facilities.
(c) Conservation of water by improving irrigation efficiencies.
(d) Recycling and reuse of wastewaters.

Tourism:

(a) Development of water to support tourism balanced. with competing agricultural and environmental needs.
(b) Cost-sharing in facilities construction by developers.

Health:

(a) Ensuring safe drinking water.
(b) Protecting coastal waters and stream habitats.
(c) Maintaining surface and ground water quality through regulations.

Recreation:

(a) Recreational use of watershed areas.
(b) Competition between recreation and other uses for instream flows.

Conservation Lands:

(a) Protection and improvement of watersheds.
(b) Flood and tsunami damage reduction.
(c) Adminstration of erosion and sedimentation control programs.

Housing:

(a) Development of water infrastructure in support of housing.
(b) Housing cost increases from possible required installation of water-conserving fixtures.
(c) Endangerment of watershed and recharge areas by new residential developments.

Energy:

(a) Implications of rising power costs on water supply development.
(b) Economic feasibility of hydropower in Hawaii's environment.

(c) Conservation of energy through increased efficiency in water use.
(d) Compatibility of hydropower development with developments for supply storage fisheries, recreation, and flood control.

Education:

(a) Enhancement of water conservation curriculum in Hawaii schools.
(b) Augmented water-related research.

Transportation:

(a) Minimization of adverse impacts from highway construction; eg. lowering of water tables by mountain tunnelings, losses of watershed land by new highways, and erosion of soils during construction.
(b) Conservation of water supplies by utilizing lower qualtiy water for highways landscaping.

Historic Preservation:

(a) Protection of historic sites through judicious water facility siting or routing.
(b) Preservation of scenic water resources of historic significance.

Table 1. RELATIONSHIP OF THE WATER RESOURCES FUNCTIONAL PLAN TO THE WATER-RELATED POLICIES OF THE HAWAII STATE PLAN

Water-Related Objectives and Policies of Hawaii State Plan	Relationship*	
	Complementary to Water Functional Plan Purposes	Possible Conflict with Water Functional Plan
Population		
Ensure that adequate support services and facilities are provided to accommodate the desired distribution of future growth throughout the State.	●	O
Foster an understanding of Hawaii's capacity to accommodate population needs.	◒	O
Economy		
Promote and protect intangible resources in Hawaii, such as scenic beauty and the aloha spirit, which are vital to a healthy economy.	◒	O
Assure the availability of lands suitable for agriculture, with adequate water to accommodate present and future needs.	●	O
Encourage investment and employment in economic activities that have the potential for growth such as diversified agriculture, aquaculture, apparel and textile manufacturing, and energy and marine-related industries.	◒	O
Environment		
Exercise an overall conservation ethic in the use of Hawaii's natural resources.	●	O
Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.	●	O

* ● Highly significant; ◒ Significant; O Of moderate significance.

Table 1 (continued)

Water-Related Objectives and Policies of Hawaii State Plan	Relationship*	
	Complementary to Water Functional Plan Purposes	Possible Conflict with Water Functional Plan
Consider multiple uses in watershed areas, provided such uses do not detrimentally affect water quality and recharge functions.	●	◒
Encourage the protection of rare or endangered plant and animal species native to Hawaii and their habitats.	◒	O
Pursue compatible relationships among activities, facilities, and natural resources, especially within shoreline areas.	◒	O
Promote the visual and aesthetic enjoyment of mountains, ocean vistas, scenic landscapes, and other natural features.	◒	◒
Foster educational activities that promote a better understanding of Hawaii's limited environmental resources.	◒	O
Promote the proper management of Hawaii's land and water resources.	●	O
Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters.	●	O
Reduce the threat to life and property from erosion, flooding, tsunamis, earthquakes, and other natural or man-induced hazards and disasters	◒	O
Encourage urban developments in close proximity to existing services and facilities.	●	O
Foster recognition of the importance and value of the land, air, and water resources to Hawaii's people and their cultures.	◒	O

* ● Highly significant; ◒ Significant; O Of moderate significance.

Table 1 (continued)

Water-Related Objectives and Policies of Hawaii State Plan	Relationship*	
	Complementary to Water Functional Plan Purposes	Possible Conflict with Water Functional Plan
Water Facilities		
Relate growth activities to existing and potential water supply.	●	◒
Support research and development of alternative water sources.	●	O
Reclaim and encourage the productive use of runoff water and waste water discharges.	●	O
Assist in improving the quality, efficiency, service, and storage capabilities of water systems for domestic and agricultural use.	●	O
Support water supply services to areas experiencing critical water problems.	●	O
Promote water conservation practices.	●	O
Socio-cultural Advancement		
Promote the recreational and educational potential of natural resources having scenic, open space, cultural, historical, geological, or biological values.	◒	O
Ensure opportunities for everyone to use and enjoy Hawaii's recreational resources.	◒	O
Assure the availability of sufficient resources to provide for future recreational needs.	◒	O
Government		
Provide for necessary public goods and services not supplied by the private sector.	◒	O
Promote the consolidation of state and county governmental functions to minimize the ineffective and inefficient delivery of government programs and services.	◒	O

* ● Highly significant; ◒ Significant; O Of moderate significance.

Table 2 . RELATIONSHIP OF WATER RESOURCES FUNCTIONAL PLAN TO OTHER STATE FUNCTIONAL PLANS

Other Functional Plans	Nature of Relationship*		
	Impacts Upon	Is Impacted By	Interrelates With
Transportation	◒	◒	O
Agriculture	●	●	●
Tourism	◒	◒	◒
Housing	●	●	●
Conservation Lands	◒	◒	◒
Education	O	O	O
Energy	◒	◒	O
Higher Education	O	O	O
Health	◒	◒	◒
Historic Preservation	O	O	O
Recreation	◒	◒	◒

*Denotes:

- ● Highly significant
- ◒ Significant
- O Of moderate significance

CHAPTER III

SUPPORTIVE RATIONALE

III. SUPPORTING RATIONALE

A description of Hawaii's water situation is presented in this section. This presentation has a two-fold purpose. First, the information is intended to increase public awareness of Hawaii's water situation and informed participation in basic decisions affecting the State's water future. Second, the information serves as a substantive basis for the formulation of water resources objectives, policies, and implementing actions in conjunction with the earlier discussion on the role of the State Water Resources Development Plan. These policy statements and implementing actions are to provide guidance to decision-makers in considerations which affect the delivery of services, the development and allocation of resources, and the determination of priorities in the water area.

A. Planning Considerations

The procedures used in developing this Functional Plan on Water Resources Development consisted of the following four steps: (1) an inventory was made of basic resources and related development within the state; (2) future needs for water resources and services were estimated; (3) ways to meet needs for each purpose were studied; and (4) programs and projects that would best serve all purposes and meet requirements for resource conservation, utilization, and development were selected.

Specific guidelines adopted to govern the study and this planning report include the following:

(1) The functional plan will amplify the objectives and policies of the Hawaii State Plan. An early action phase will include those projects and programs found to be needed, feasible, and desirable.

(2) Implementing actions will be scheduled to conform with the priority directions set forth in the Hawaii State Plan. Priority actions for water use and development, as enumerated in the Hawaii State Plan, consist of the following:

(a) Encourage water conservation to reduce the per capita water consumption rate through education and the promotion of conservation awareness.

(b) Assist agriculture in determining the feasibility of using wastewater effluent to irrigate crops.

(c) Encourage restriction of new urban development in areas where water supply is insufficient for both agricultural and domestic uses.

(d) Improve irrigation technology to increase the effective and efficient use of water.

(e) Increase the support for research and development of alternative water sources.

(3) The extent of future water needs for the state's growing population will be based on population projections developed by the State Department of Economic Development. The Department has requested that all functional plan agencies use the Series II-F projections in the preparation of their functional plans. These projections distribute the state population among the various counties (Table 3). In turn, the general plan of each county implicitly sets population distribution within the county (Table 4). Use of the specified population data base will assure some measure of uniformity and consistency, as well as validity, in the determination of future water related services and capital requirements.

Table 3. PROJECTED RESIDENT POPULATION, BY COUNTIES

(The Series II-F projections as recommended for planning purposes by the State Dept. of Planning & Economic Development)

Year	State Total*	County			
		Honolulu	Hawaii	Kauai	Maui
1980	942,300	753,700	84,700	36,500	67,400
1985	1,020,900	803,800	95,200	40,600	81,400
1990	1,091,500	845,000	105,100	46,500	94,900
1995	1,163,800	885,800	115,000	53,100	109,900
2000	1,225,900	917,400	123,300	60,400	124,700

*Resident totals include armed forces and their dependents but exclude visitors present. Because of independent rounding, detail may not add exactly to indicated totals.

Source: Hawaii State Department of Planning & Economic Development, "Revised Population and Economic Projections, 1975-2000 (Mar. 1, 1978)

Table 4. PROJECTED RESIDENT POPULATION AND DISTRIBUTION*
(County-wide figures are the State DPED Series II-F projections; intra-county figures (undergoing revision) are those furnished by the counties.)

Planning Areas	Year 1980	1985	1990	1995	2000
HAWAII	84,700	95,200	105,100	115,000	123,300
Kau	3,800	4,200	--	4,900	--
Kona	12,800	14,900	--	23,400	--
Kohala	8,400	10,000	--	13,700	--
Hamakua-N.Hilo	6,700	7,100	--	6,800	--
Hilo	45,700	50,500	--	56,100	--
Puna	7,300	8,500	--	10,100	--
OAHU	753,700	803,800	845,000	885,800	917,400
PUC	--	--	--	--	458,700
Ewa	--	--	--	--	100,900
Central Oahu	--	--	--	--	122,900
East Honolulu	--	--	--	--	57,800
Koolaupoko	--	--	--	--	119,300
Koolauloa	--	--	--	--	10,100
North Shore	--	--	--	--	12,800
Waianae	--	--	--	--	34,900
MAUI	58,700	69,900	81,500	92,800	--
H.A. I (Lahaina)	9,000	10,700	12,500	14,400	--
H.A. II (Wailuku-Kahului)	22,300	26,500	30,800	35,100	--
H.A. III (Makawao, Kula, Por. Kahului)	25,700	30,800	36,100	41,000	--
H.A. IV (Hana)	1,150	1,300	1,450	1,600	--
H.A. V (Kipahulu-Kaupo)	550	600	650	700	--
MOLOKAI	6,400	7,400	8,100	8,600	--
H.A. I (N.E. Molokai)	300	300	300	350	--
H.A. II (S.W. Molokai)	1,100	1,250	1,350	1,400	--
H.A. III (Cen. Molokai)	4,300	5,000	5,500	5,800	--
H.A. IV (West Molokai)	700	850	950	1,050	--
LANAI	2,300	2,700	3,100	3,500	--
H.A. I (N. Lanai)	--	--	--	--	--
H.A. II (S. Lanai)	2,300	2,700	3,100	3,500	--
KAUAI	36,500	40,600	46,500	53,100	60,400
Waimea-Kekaha	5,300	5,500	7,100	6,200	7,000
Hanapepe-Eleele	3,300	3,400	4,000	3,900	4,500
Koloa-Poipu	8,100	9,200	10,500	12,300	13,900
Lihue	7,400	9,000	9,600	11,800	13,300
Kapaa-Wailua	10,200	10,600	12,500	12,800	13,800
Northshore	2,200	2,900	2,800	6,100	7,900

*Resident totals include armed forces and their dependents, but exclude visitors present.

(4) In determining future water needs, all of the various uses will be given attention. That is, to the extent practicable, the plan will balance economic development and environmental quality. Water for social and ecological purposes will be considered, as well as water to satisfy urban and agricultural water requirements.

(5) While the functional plan does support the growth policies of the Hawaii State Plan, functional plan objectives and program recommendations are not specifically directed toward growth control, per se. Implementation of water programs would permit or assist growth, but would not, of itself, cause growth to occur. Growth control lies outside the immediate purview of water resources planning.

(6) The successful development and implementation of this functional plan will require the close cooperation and coordinated effort of many federal, state, and county agencies and will depend, in large measure, on public interest, cooperation, and participation in the planning and implementation processes. Lines of communication will be established with state and county agencies having water related interests. The functional plan will draw heavily and expand upon the findings and recommendations of the earlier, federally sponsored, Hawaii Water Resources Regional Study and upon the Governor's ad hoc State Water Commission. Further, county general plans and development plans will be utilized to formulate urban water programs and projects, particularly those of the county boards of water supply. Public participation through informational meetings and the activities of the Functional Plan Advisory Committee and the Hawaii State Plan Policy Council will provide guidance and monitoring to arrive at a suitable plan.

In light of the diversity of implementing actions recommended under this Water Resources Development Plan, the mechanism for priority setting becomes important. The above guidelines provide that whenever possible the scheduling of implementing actions will be directed by the Priority Directives set forth in the Hawaii State Plan. That is, priority setting should be reflective of current social values and objectives as embodied in the Priority Directions, which statutorily are subject to updating every two years.

Within any water use category, the recommendations offered by the responsible agencies have been used in setting program and project priorities. For example projects involving municipal water facilities identified in this Water Resources Development Plan are generally prioritized in accordance with the established criteria of the responsible county water boards, and projects involving water for agricultural parks are prioritized in consistency with agriculture park development schedules adopted by the responsible agency, the State Department of Agriculture.

On the other hand, the mechanism for setting priorities among the various water use categories--municipal, agricultural, instream, environmental, etc.--is presently not well defined, and sometimes decisions must be made with incomplete information. For such priority setting within this Plan, comparison among recommended implementing actions were made in consideration of three broad sets of criteria, within the context of current Priority Directions: economic efficiency, equity, and administrative considerations. The traditional economic development objective continues to be a criterion for water project selection, requiring cost comparisons among parojects. Other recent objectives, notably environmental quality, are now given equal considera-

tion. Further, cost sharing as promoted by this Plan, would tend toward economic efficiency, and only meritorious projects would be advanced.

The criterion of equity is applicable where competition for limited supplies is keen and the selection of one project over the others results in hardship or damages. Here, preference was given those projects whose purposes are mutually supportive; e.g., those municipal water projects that accommodate agricultural water needs in areas where agricultural water systems are non-existent. The criterion of administrative consideration is applied in those situations where projects are affected by agency actions. Prevailing administrative policies oftentimes dictate whether a proposed project deserves priority. The procedures under the Ground Water Use Act for example, determines priority setting among competing projects in designated water-short areas. The Plan's recommended statewide water use control legislation would generate comprehensive criteria to administratively set preferences and implementation priorities among future water projects.

B. Physical Setting and Available Water Resources

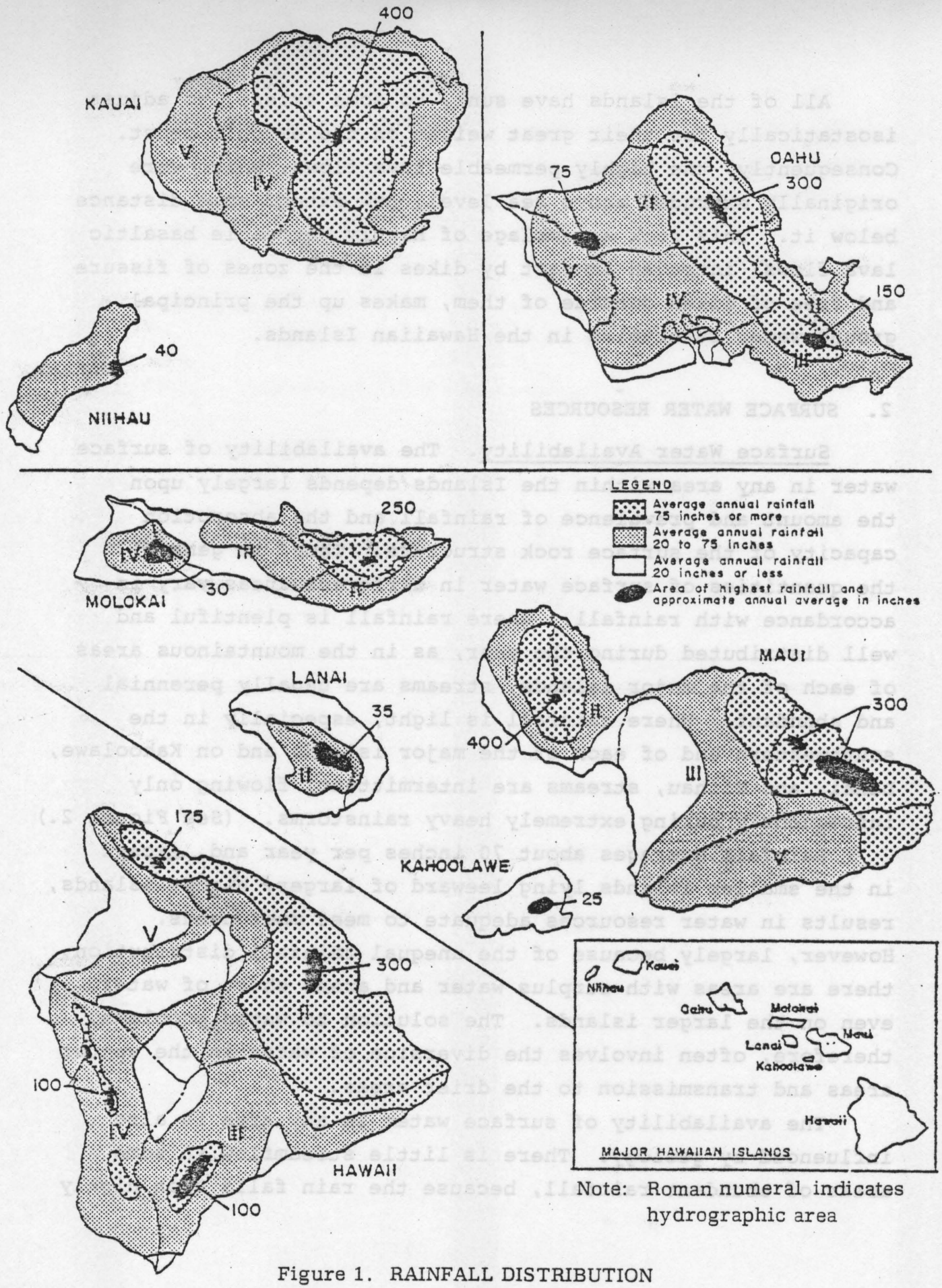
1. CLIMATE AND GEOLOGY

Climate. Hawaii owes its distinctive climate to its latitude, insular characteristics, topography, prevailing trade winds, and relative infrequency of severe weather. While typically mild and relatively uniform throughout the year, the climate varies markedly from place to place because of topography, and from time to time because of daily and seasonal patterns and occasional storms.

Hawaii's climate ranges from subtropical near sea level to subarctic on the uppermost slopes of its highest mountains, and from some of the wettest areas on earth to desert conditions within the span of a few miles. Rainfall gradients are steep, often 25 inches per mile and as much as 118 inches per mile in one location on Kauai. Drought and flooding are both major problems. On the one hand, dry areas may receive nearly a year's average rainfall in a single day; on the other, even normally wet areas may experience long periods of low rainfall. Rainfall distribution in the islands is shown on Figure 1.

Geology. The Hawaiian Archipelago is a group of shoals, reefs, and islands trending northwest to southeast more than 1,500 miles across the Central Pacific. The Hawaiian Islands, which lie at the southeastern end of the archipelago, constitute more than 99 percent of its total land area.

The Hawaiian Islands are the tops of shield volcanoes rising from the ocean floor, the oldest being Kauai in the northwest and the youngest being the island of Hawaii in the southeast. Each of the islands consists of one to five volcanic domes, the bulk of which are composed of thousands of basaltic lava flows. The lavas issued from each volcano in repeated outpourings from narrow zones of fissures, first below sea level, then above it, to form huge mountain masses. The basaltic lavas that were extruded above sea level are generally thin-bedded and highly clinkery and permeable. In contrast, the lavas extruded in water were quickly chilled, are less clinkery, more massive, and are generally less permeable.



Note: Roman numeral indicates hydrographic area

Figure 1. RAINFALL DISTRIBUTION

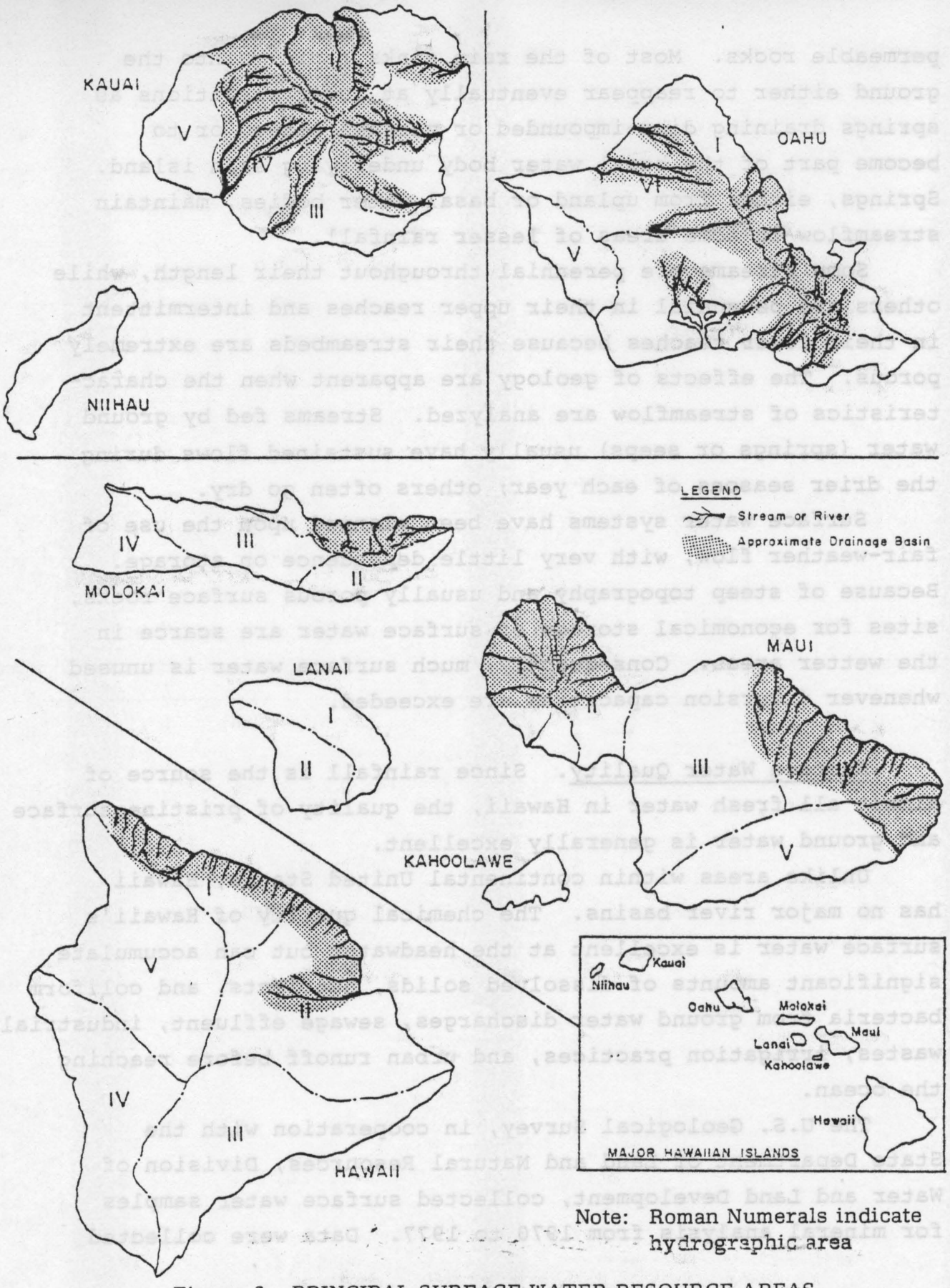
All of the islands have sunk, to some extent, to adjust isostatically for their great weight on the earth's crust. Consequently, the highly permeable lava flows, which were originally extruded above sea level, now extend some distance below it. This rock assemblage of highly permeable basaltic lava flows, intruded in part by dikes in the zones of fissure and free of dikes outside of them, makes up the principal ground water reservoirs in the Hawaiian Islands.

2. SURFACE WATER RESOURCES

Surface Water Availability. The availability of surface water in any area within the Islands depends largely upon the amount and prevalence of rainfall and the absorption capacity of the surface rock structure. Thus, in general, the quantities of surface water in different areas vary in accordance with rainfall. Where rainfall is plentiful and well distributed during the year, as in the mountainous areas of each of the major islands, streams are usually perennial and abundant. Where rainfall is light, especially in the southwestern end of each of the major islands and on Kahoolawe, Lanai, and Niihau, streams are intermittent, flowing only infrequently during extremely heavy rainstorms. (See Figure 2.)

Rainfall averages about 70 inches per year and, except in the smaller islands lying leeward of larger, higher islands, results in water resources adequate to meet most needs. However, largely because of the unequal rainfall distribution, there are areas with surplus water and areas short of water, even on the larger islands. The solution to water problems, therefore, often involves the diversion of water in the wetter areas and transmission to the drier areas.

The availability of surface water in any area is also influenced by geology. There is little streamflow in some areas of abundant rainfall, because the rain falls upon highly



Note: Roman Numerals indicate hydrographic area

Figure 2. PRINCIPAL SURFACE WATER RESOURCE AREAS

Source: Hawaii Water Resources Plan, January 1979

permeable rocks. Most of the rain sinks rapidly into the ground either to reappear eventually at lower elevations as springs draining dike-impounded or perched water, or to become part of the basal water body underlying each island. Springs, either from upland or basal water bodies, maintain streamflow in some areas of lesser rainfall.

Some streams are perennial throughout their length, while others are perennial in their upper reaches and intermittent in their lower reaches because their streambeds are extremely porous. The effects of geology are apparent when the characteristics of streamflow are analyzed. Streams fed by ground water (springs or seeps) usually have sustained flows during the drier seasons of each year; others often go dry.

Surface water systems have been planned upon the use of fair-weather flow, with very little dependence on storage. Because of steep topography and usually porous surface rocks, sites for economical storage of surface water are scarce in the wetter areas. Consequently, much surface water is unused whenever diversion capacities are exceeded.

Surface Water Quality. Since rainfall is the source of almost all fresh water in Hawaii, the quality of pristine surface and ground water is generally excellent.

Unlike areas within continental United States, Hawaii has no major river basins. The chemical quality of Hawaii's surface water is excellent at the headwater but can accumulate significant amounts of dissolved solids, nutrients, and coliform bacteria from ground water discharges, sewage effluent, industrial wastes, irrigation practices, and urban runoff before reaching the ocean.

The U.S. Geological Survey, in cooperation with the State Department of Land and Natural Resources, Division of Water and Land Development, collected surface water samples for mineral analysis from 1970 to 1977. Data were collected

during periods of high and low flows to help define the baseline chemical quality of surface water streams. Except for selected streams, the present monitor is limited to taking periodic field pH, temperature, and conductivity readings.

The State Department of Health has broad jurisdiction over the health and sanitary conditions of Hawaii's water resources and monitors both bacteriological and chemical quality. Coliform data are plentiful for drinking water supplies and coastal areas, but are scarce for freshwater streams. Other data are collected during special investigations and research projects.

Chemical Quality. The chemical quality of stream water is excellent. It generally follows a pattern of dilution caused by rainfall. No significant levels of pesticide or toxic chemicals have been detected.

The dissolved-solids content of stream waters ranges from less than 50 mg/L (milligrams per litre) at headwaters to greater than 200 mg/L near the stream mouth. The increase, due primarily to ground water discharge, usually occurs at lower reaches. Irrigation return flows and urban activities also add to the dissolved-solids content.

Water is commonly classified as hard or soft. The hardness of water can be attributed to the presence of dissolved calcium and magnesium. It is considered soft when the hardness value is less than 60 mg/L expressed as calcium carbonate. Most surface water in Hawaii is soft, except for streams fed principally by basal ground water or irrigation return flows.

Physical Quality. The physical quality of stream water is attributable to its "flashy" characteristics. High turbidity and suspended sediment concentrations occur during periods of heavy rainfall. Storm are of short duration, and most streams

revert to base flow and clear conditions within a few hours. During base flow, stream turbidity seldom exceeds 5 JTU (Jackson Turbidity Units); but, during storm runoff, readings greater than 100 JTU are common.

The color of surface water varies in different areas, depending upon the presence of color bodies of predominantly organic origin. The color bodies often taste peaty, rendering the water a esthetically unsuitable for human consumption. Streams in South Kohala on the island of Hawaii have reported values of 22 to 320 color units.

Stream temperatures do not vary significantly, generally fluctuating with ambient conditions. Recorded temperatures have ranged from 14 to 30 degrees centigrade. Temperatures are higher in concrete lined channels and are highest at base flow conditions.

Biological Quality. Bacteriological data for surface streams are scanty. There has been no systematic monitoring of bacterial densities, and meaningful interpretation cannot be made. But, research data and grab-sample analyses from Oahu streams generally indicate poor bacterial quality. Total coliform counts often exceed 1,000 colonies per millilitre of water. The counts are generally higher during wet weather conditions. Densities of both total coliform and fecal coliform in many Oahu streams exceed Hawaii's water quality standard. Treatment is necessary to lower bacterial densities for domestic uses.

Limnological surveys on 153 streams have been completed by the State Department of Land and Natural Resources, Division of Fish and Game, to assess the potential for developing public fishing areas. Preliminary findings indicate good development potential for 111 streams; poor for 21 streams; and little for the other 21 streams.

Suitability for Use. Surface water in Hawaii is chemically suitable for most uses. All the streams for which data are available are suitable for domestic and municipal use, but treatment may be required to remove bacterial and organic contaminants. In some areas, removal of color and turbidity may also be required to meet recommended standards.

Surface water, generally of low salinity, is suitable for irrigation. Water with high salt content, found in tidal areas, may not be suitable for certain sensitive crops.

3. GROUND WATER RESOURCES

Ground Water Availability. Ground water supplies are being developed more and more for domestic, industrial, and even agricultural use because of the unreliability of surface water supplies.

Ground water is that portion of rainfall that infiltrates into the ground and recharges underlying reservoirs. The quantity of ground water recharge is dependent upon the availability of rainfall and the absorption capacity of the surface rock structure. Except where sugarcane is heavily irrigated, ground water recharge generally increases as rainfall increases.

The capacity of the surface rock structure to absorb rainfall at deep infiltration levels is generally correlative with water bearing property. The pervious nature of surface volcanic rocks is commonly reduced considerably by deep weathering. Hence, the surface rock structure of younger islands, such as Hawaii, are generally more pervious than those of an older island, such as Kauai, even though the rock types and eruption characteristics may be similar.

Ground water occurs as basal water, as dike-impounded water, and as perched water (Figure 3).

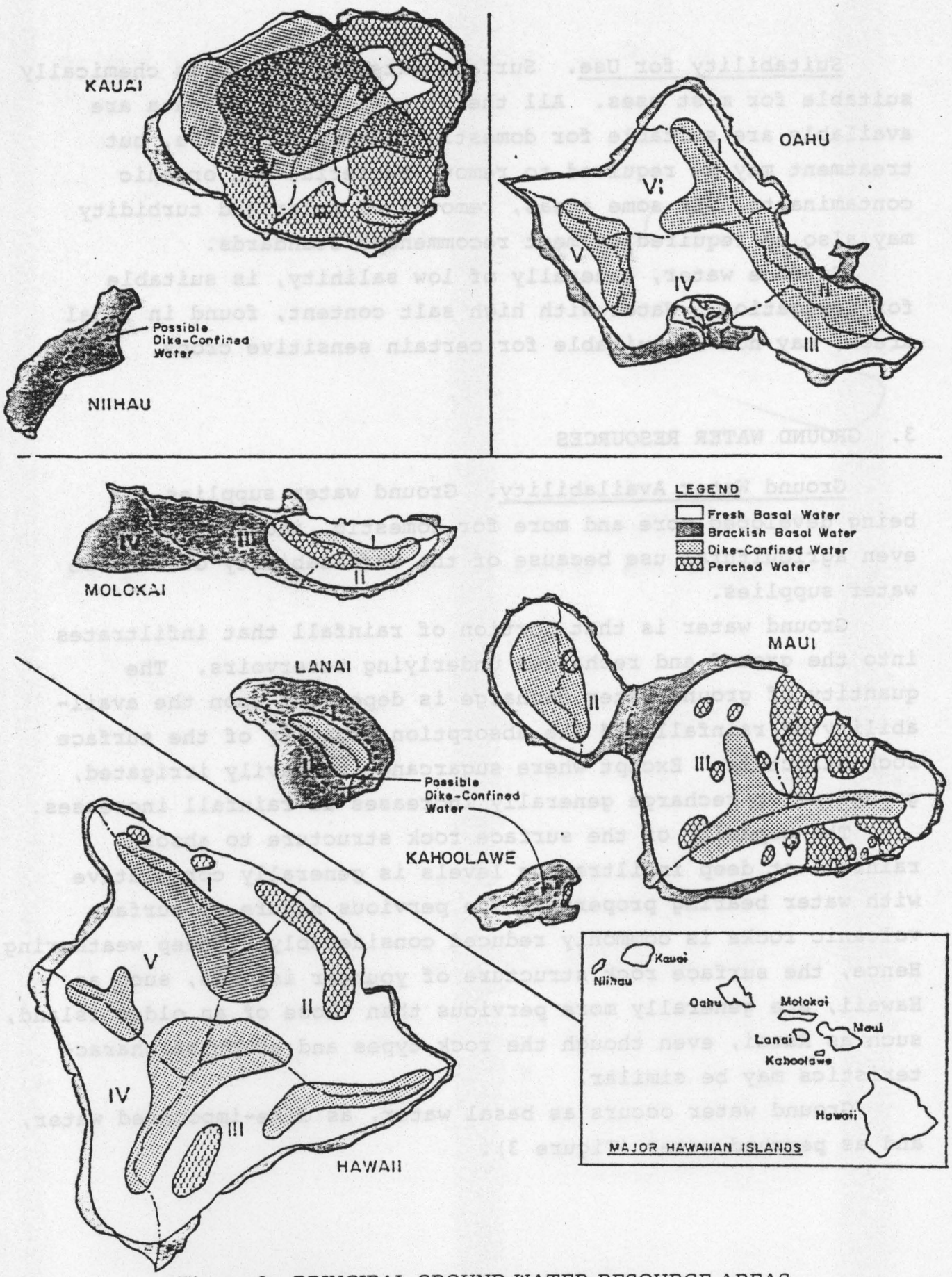


Figure 3. PRINCIPAL GROUND WATER RESOURCE AREAS

Source: USGS, 1978, "Summary Appraisals of the Nation's Ground-Water Resources"

Ground water in dike-free rocks outside the eruptive zones occurs as basal water. The fresher portion forms a lens-shaped body floating on ground water with salinity approaching that of seawater. Where permeable rocks are overlain by caprock material in coastal plains, basal water occurs under artesian conditions commonly to several hundred feet. Where caprock is absent, basal water bodies are thin, are generally brackish near the coast, and occur under water-table conditions. Basal water bodies provide most of the ground water supplies developed in the Hawaiian Islands.

Dike-impounded ground water bodies occur mostly in dike-intruded lava flows and occasionally in other rock types within the eruptive zones. Because they occur and are easily developed at higher elevations, they are important sources for gravity-flow water systems for domestic and irrigation purposes. The natural discharge of dike-impounded water, as springs, provides the base flow of many large perennial streams.

Ground water perched above dike-impounded and basal water is common in the Islands. Most perched water bodies are small, however, and quickly drained after rains. Perching members are weathered ash or lava surfaces, soil, or any poorly permeable horizon interbedded in lava flows, cinders, calcareous sediments, or other permeable rocks. Many perched water sources have been developed by tunneling to provide important water supplies, especially at high altitudes in isolated places.

Ground Water Quality. Ground water is the principal source of potable water in Hawaii. Factors affecting the quality of ground water are: (1) overdraft, which may lead to salt water encroachment; (2) agricultural and industrial uses and discharges, which could deteriorate present and potential water supplies; and (3) indiscriminate surface and underground waste disposal, which could introduce potential contaminants.

In general, good quality water is available in Hawaii's major basal, dike-impounded, and perched water bodies. All ground water developed for public and domestic purposes are chemically suitable for use without treatment. No significant levels of organic contaminants, pesticides, or toxic chemicals have been detected. The dissolved-solids concentrations are generally higher in basal water than in perched or dike-impounded water. Hardness ranges from less than 60 mg/L to more than 1,000 mg/L.

Water containing more than 500 mg/L of dissolved solids is plentiful. Although not presently considered suitable for domestic use, such water may be important for future needs. These fresh-to-brackish water sources are located in permeable lavas and sedimentary deposits in coastal areas and are highly susceptible to contamination. They are presently used as sources of water supply for agriculture and industry.

The geohydrologic environment and the chemical characteristics of ground water might be altered by man's activities. Overpumpage can cause upconing of saline water. Fertilizers and other soluble chemicals applied on the surface can be leached into basal aquifers. Indiscriminate subsurface waste disposal could deteriorate the quality of Hawaii's ground water.

The physical quality of ground water is excellent. It is usually free of color and contains little or no turbidity. The pH values range between 6.8 and 8.4 units. No offensive taste or odor has been found in potable ground water supplies.

Incidence of bacterial contamination in ground water is low. Those excessive coliform counts detected generally have been traced to local contamination, bad sampling techniques, or faulty distribution systems.

4. CURRENT WATER USE

Water use in Hawaii in 1975 averaged about 1,755 mgd, of which about 890 mgd, or 51 percent, was derived from ground water sources. Surface water use was 810 mgd, 46 percent, and recycled water was 56 mgd, 3 percent. Table 5 shows water usage in the islands.

The largest use of water, other than saline water for thermoelectric cooling purposes, is for irrigation (970 mgd). Of this amount, as much as 90 percent is used for irrigation of sugarcane in dry, sunny areas. Sugar yields are highest where sugarcane is irrigated; water use may be as much as 12 acre-feet per year. In many places, irrigation water is imported from distant wet areas. Upwards of 500 mgd of irrigation water is currently diverted from wet to dry areas.

The impact of exportation on ground water resources in wet areas is usually not pronounced, because much of the exported water is natural ground water discharge. However, the impact is pronounced on ground water in the dry areas to which the water is delivered for irrigation. When used for furrow irrigation, as much as 60 percent of the water applied infiltrates and recharges the underlying ground water reservoir. In many dry areas, the return of irrigation water represents the principal source of ground water recharge. The effect is to maintain a usable ground water resource where none may have existed previously.

5. FUTURE WATER USE

Hawaii's total water resources are far greater than total demands for any predictable time in the future. But aggregates and averages tend to mask local and periodic deficiencies.

Primary water requirements are: (1) municipal supplies to serve communities, providing for domestic, commercial, and some industrial purposes; (2) industrial supplies, privately

Table 5. WATER USE, 1975
(In million gallons per day)

	Hawaii	Maui	Lanai	Molokai	Oahu	Kauai	Niihau
Municipal	18	18	1	1	183	13	*
Agricultural	17	410**	1	4	238**	301**	*
Industrial:							
Thermoelectric -							
Fresh	79	25	0	*	16	17	0
Seawater	(5)	(42)	0	0	(959)	(27)	0
Hydroelectric	70	47	0	0	0	87	0
Other	95**	66**	0	*	34	37**	0
Total	278	564	2	5	471	455	*
Total including seawater	(283)	(606)	2	5	(1,430)	(482)	*

*Less than 1 mgd.
**Agricultural and industrial water uses include recycled water.
Source: Water Use Survey, 1975, USGS

owned and serviced; (3) agricultural supplies, both private and public, for irrigation and livestock; and (4) instream uses, including recreation, fish and wildlife habitat, water quality control, and aesthetic enjoyment. (See Table 9.)

Estimates of future water requirements in this functional plan are based on a series of assumptions. The broadest of these are that there will be a continued upward trend in employment and production consistent with the objectives of the Hawaii State Plan, and that government policies and programs will encourage the development and conservation of water supplies.

Future municipal water supply needs are projections of recent and current practices and requirements, adjusted for expected trends and special conditions, such as implementation of water conservation measures. Series II-F population projections, developed by the State Department of Planning and Economic Development and disaggregated by county planning departments, have been used to estimate future water demand.

Estimates of future self-supplied industrial water needs are based upon forecasts developed by the Office of Business Research and Analysis of the U. S. Bureau of Domestic Commerce. An important assumption underlying the forecasts is that the objectives of the 1972 Water Pollution Control Act Amendments will be met; by the year 2000 there should be no unregulated discharges of pollutants. This translates into steadily increasing recirculation rates by large water users and discharge of all wastewater into the public sewer system by small water users.

Other important assumptions derived from the 1972 Pollution Control Act are that cooling water, comprising most of the industrial water now used in the state, will be recycled through lagoons or towers, and that power plants using brackish water once-through for cooling will switch to closed systems

using fresh water. These key assumptions result in decreasing industrial water use in the future, despite increased industrial production.

Since the use of water for crop irrigation far exceeds that for any other use, estimates of future irrigation water requirements are of considerable importance. Determining such water needs is difficult, however, because there is no reasonably certain method for projecting the rate of agricultural growth or predicting expansion or decline. Problems relating to irrigation costs, the current flux in water rights, and the scarcity of developable sources of supply, all contribute to the uncertainty in predicting future needs. Also unknown is the replacement level for agricultural land being taken out of production for purposes such as urban growth, industrial parks, and highway construction.

However, it is reasonably certain that the sugar industry will continue to produce Hawaii's biggest export commodity. Current industry programs, such as consolidation of plantations, new irrigation and harvesting methods, and improved cane cleaning processes at the mills indicate a stable outlook for the years ahead. Even with rapid urbanization, agriculture is expected to remain the dominant water user for the immediate future.

Instream flow requirements--the amount of water flowing in natural stream channels needed to sustain instream values at an acceptable level--are difficult to quantify and there is presently a lack of both meaningful data and suitable methodology to ascertain minimum instream flows.

6. WATER AVAILABLE FOR FUTURE USE

Most of the current demand for water is in dry, sunny areas where sugarcane yields are highest and where most of

the population reside. No change is foreseen in this use pattern for the future, except that the demand for domestic and commercial supplies will increase significantly, due to the continued development of tourist and residential complexes in coastal areas. In some areas, the demand is already greater than the supply and must be met by importing water. Additional imports are likely to be required in the future for other areas of high growth.

Estimates of Rainfall Distribution. Table 6 gives a rough estimate of rainfall distribution in the hydrographic areas of each island. The boundaries of the areas, based on topography, generally delineate the major surface drainage basins. (See Figures 1 and 2.) Ground water pumpage and the quantity of water transported by pipelines and ditches from and into the various hydrographic areas are also listed in Table 6.

It should be emphasized that the figures on distribution of rainfall listed in Table 6 and shown in Figure 1 are only gross estimates. However, they do reflect the availability and development potential of surface water and ground water in the respective hydrographic areas, based on known or inferred conditions of rainfall, and the surface and sub-surface geology.

Estimate of Available Water Supply. Table 7 lists and Figures 5 and 6 show water use and estimated availability by islands and hydrographic areas.*

---

* The ground water and surface water use data are from a 1975 compilation by the U.S. Geological Survey. The estimated sustainable yield for ground water and surface water are derived from the Water Supply Study Element Report, Hawaii Water Resources Regional Study (1975), and from the State Water Commission Report (1979).

Table 6. DISTRIBUTION OF RAINFALL TO EVAPOTRANSPIRATION, RUNOFF, AND GROUND WATER RECHARGE*
(million gallons per day)

Island	Hydrographic area representing major drainage basin	Distribution of rainfall							1975 ground-water quantities (approximate)		
		Total rainfall	Evapotranspiration	Percentage of rainfall	Runoff	Percentage of rainfall	Groundwater recharge	Percentage of rainfall	Exported	Imported	Withdrawn from wells
Large islands exposed to trade winds											
Hawaii	I	1,430	695	49	430	30	305	21	5	1	5
	II	7,335	1,730	24	2,510	34	3,095	42	0	0	18
	III	2,340	[1]1,705	73	235	10	400	17	0	0	8
	IV	1,790	[1]1,265	71	180	10	345	19	0	0	3
	V	1,160	[1]745	64	180	16	235	20	1	5	1
	Totals (rounded)	14,100	6,200	44	3,500	25	4,300	31	6	6	35
Maui	I	340	125	37	145	41	70	21	0	0	60
	II	370	130	35	175	47	65	18	20	0	26
	III	685	215	31	325	47	145	21	0	180	170
	IV	925	145	16	310	34	470	51	160	0	7
	V	500	145	29	270	54	85	17	0	0	1
	Totals	2,820	760	27	1,225	43	835	30	180	180	264
Molokai	I	230	30	13	150	65	50	22	5	0	<1
	II	175	125	71	15	9	35	20	1	1	<1
	[2]III, IV	160	150	94	5	3	5	3	0	5	<1
	Totals	565	305	54	170	30	90	16	6	6	1
Oahu	I	270	90	33	85	31	95	35	3	1	8
	II	255	115	45	100	39	40	16	25	3	42
	III	235	120	51	30	13	85	36	0	22	56
	IV	425	105	25	70	16	250	59	24	25	260
	V	98	77	79	15	15	6	6	0	2	6
	VI	520	210	40	130	25	180	35	1	0	48
	Totals (rounded)	1,800	715	40	430	24	655	36	53	53	420
Kauai	I	910	160	18	[3]705	77	[4]45	5	18	0	2
	II	710	219	31	[3]455	64	[4]36	5	11	18	2
	III	280	75	27	[3]195	70	[4]10	4	25	11	12
	IV	414	89	21	[3]300	72	[4]25	6	55	25	2
	V	116	50	43	58	50	8	7	0	55	32
	Totals (rounded)	2,430	595	24	[3]1,715	70	120	5	109	109	50
Kauai	Adjusted totals	2,430	595	24	[5]1,455	60	380	16	109	109	
Large islands	Totals (rounded)	21,700	8,520	39	6,820	31	6,340	30	354	354	770
Small islands in rain-shadow of large islands											
Kahoolawe	Total	40	28	70	8	20	4	10	0	0	0
Lanai	Total	187	124	66	40	22	23	12	0	0	2
Niihau	Total	88	63	72	20	23	5	5	0	0	0
Small islands	Totals (rounded)	315	215	68	70	22	30	10	0	0	2
Region	Grand totals (rounded)	22,000	8,730	40	6,800	31	6,460	29	357	357	772

[1]Probably too high owing to infrequency of storms which provide much of rainfall total.
[2]Hydrographic areas combined owing to low rainfall density in each area.
[3]Includes large quantity of ground-water inflow, see footnote 5.
[4]Too low; ground water included with runoff.
[5]Reduced by 15 percent and added to ground water.

*USGS, 1978, "Summary Appraisals of the Nation's Ground-Water Resources".

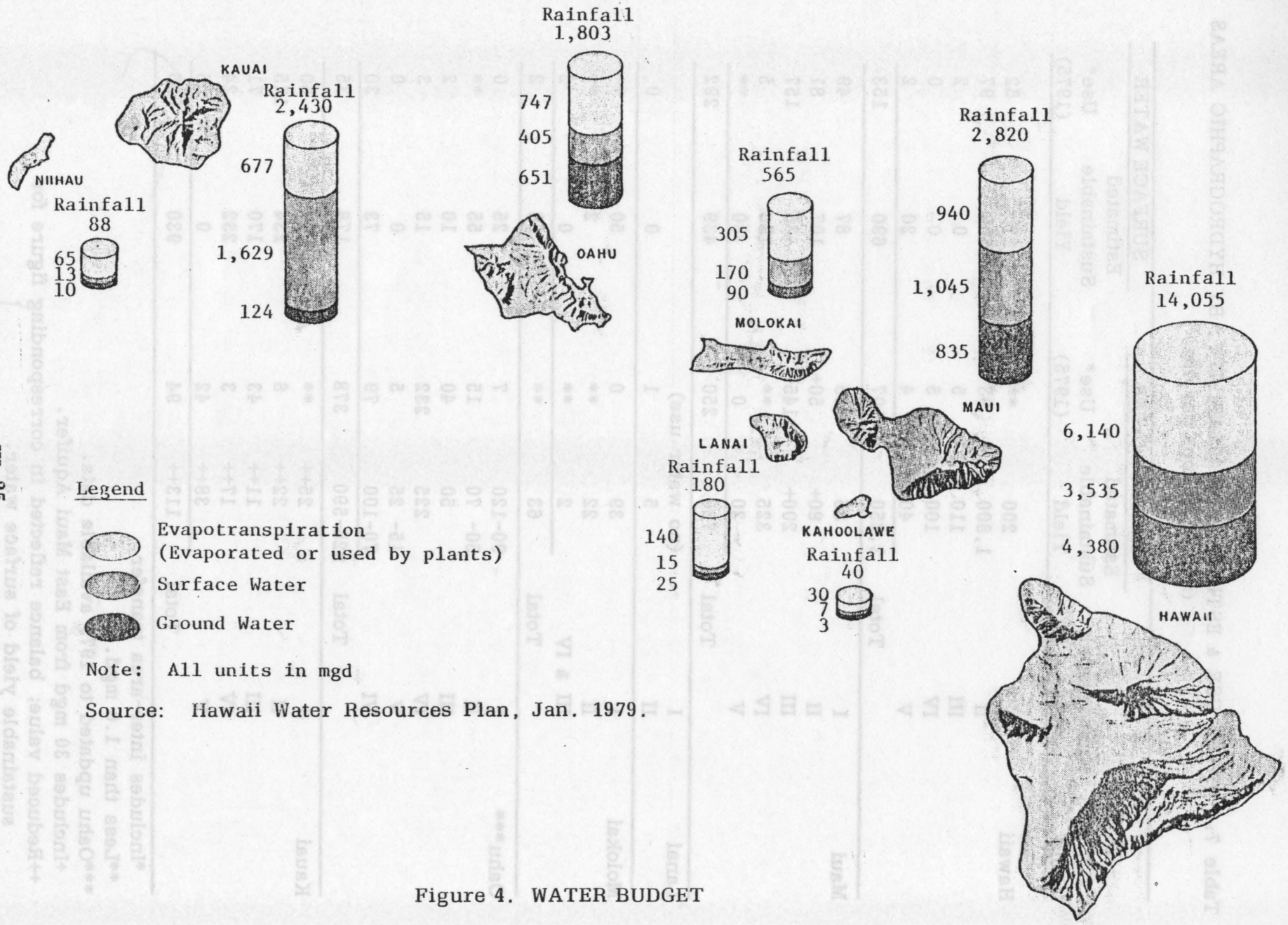


Figure 4. WATER BUDGET

Table 7. WATER USE & ESTIMATED AVAILABILITY, BY HYDROGRAPHIC AREAS
(million gallons per day)

Island	Hydrographic Areas	GROUND WATER Estimated Sustainable Yield	GROUND WATER Use* (1975)	SURFACE WATER Estimated Sustainable Yield	SURFACE WATER Use* (1975)
Hawaii	I	200	**	170	52
	II	1,800	93	500	97
	III	110	5	0	2
	IV	100	5	0	0
	V	40	4	20	2
	Total	2,250	107	690	153
Maui	I	85	55	87	49
	II	80+	50+	107	81
	III	200+	145+	35	157
	IV	325	**	180	5
	V	30	0	30	**
	Total	720	250	439	292
Lanai	I	(no water use)			
	II	5	1	0	0
Molokai	I	39	0	50	**
	II	22	**	2	**
	III & IV	2	**	0	2
	Total	63	**	52	2
Oahu***	I	90-120	7	25	0
	II	50- 70	15	55	**
	III	50	40	10	2
	IV	225	232	15	3
	V	15- 25	5	0	0
	VI	70-100	79	73	30
	Total	225-590	378	178	35
Kauai	I	25++	**	294	50
	II	22++	6	234	125
	III	11++	43	170	71
	IV	17++	3	232	24
	V	38++	42	0	56
	Total	113++	94	930	326

*Includes inter-area transfer.
**Less than 1.0 mgd.
***Oahu updated to 1979 available data.
+Includes 30 mgd from East Maui Aquifer.
++Reduced value; balance reflected in corresponding figure for sustainable yield of surface water.
Source: Hawaii Water Resources Plan, Jan. 1979, and USGS Water Use Survey, 1975

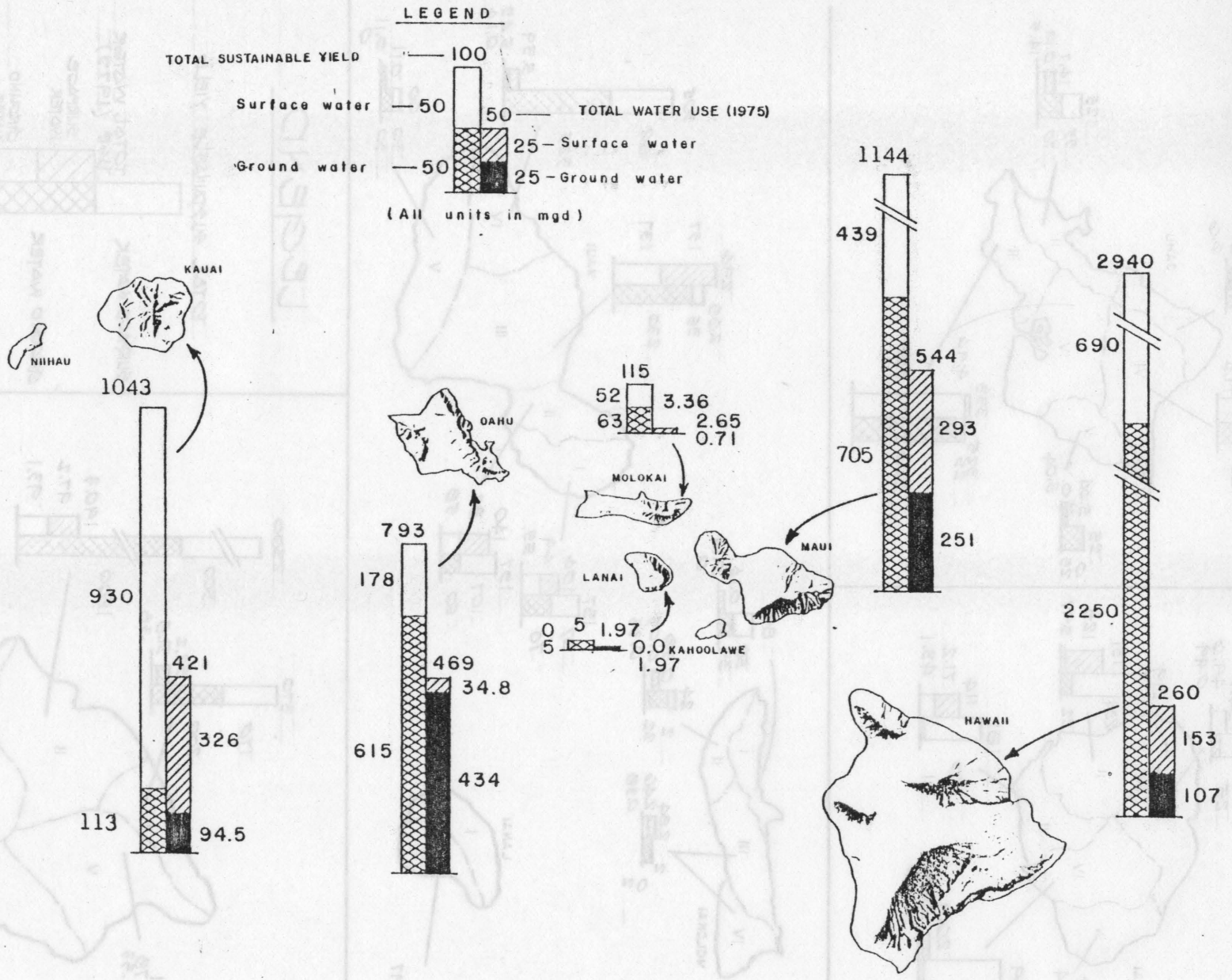


Figure 5. WATER SUPPLY AND WATER USE, STATEWIDE

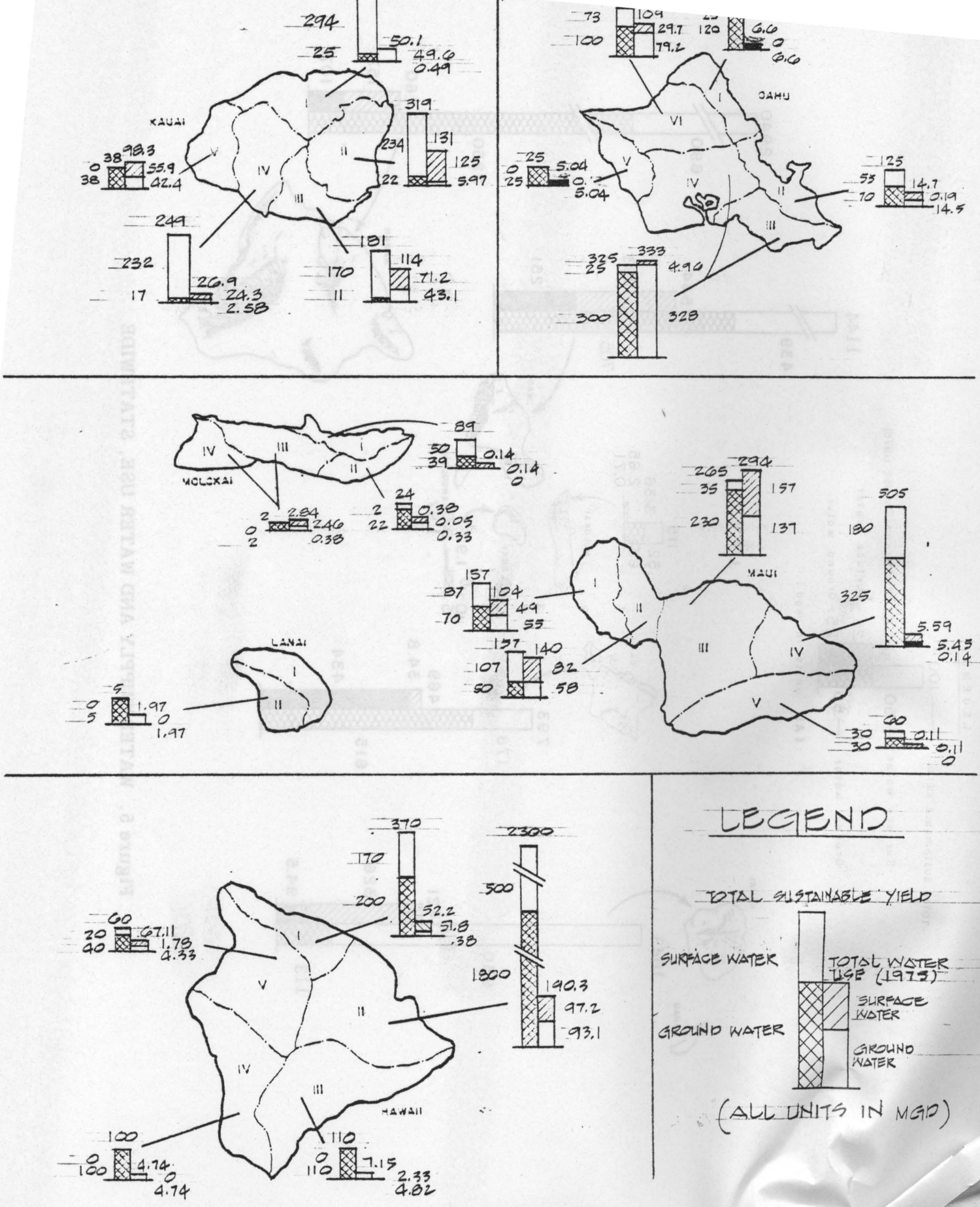


Figure 6. WATER SUPPLY AND WATER USE BY HYDROGRAPHIC AREA

The total available water supply is far greater than foreseeable future demand. However, each island is an independent geohydrologic unit, and the occurrence and availability of water vary widely among the islands and from one hydrographic area to another on each island.

Surface Water Versus Ground Water. The major source of usable surface water is the fair-weather flow, or base flow, of streams. Much of this water is transported from wet to dry areas in extensive ditch systems which were constructed about the turn of the century. More surface water could be developed today, but only at high cost because new ditches or enlargement of the existing ditches would be required. Other constraints upon further development and transfer of surface water include existing water rights, environmental considerations, and state and federal statutory regulations.

Generally, there are few constraints other than cost upon the onsite development of ground water, except where land development is extensive, such as on Oahu and possibly in the Lahaina area of Maui. Coastal areas of high water demand are generally underlain by basal ground water of poor quality. In many areas, the development of ground water supplies of suitable quality would necessitate drilling 3 to 4 miles inland to an elevation of 1,000 feet or more. A well at such elevation would have to be drilled to below sea level and the water pumped from near sea level to the land surface.

In areas where ground water and surface water sources are closely interdependent and the withdrawal of ground water is quickly reflected in reduced surface water flow, the need to maintain streamflow may restrict ground water development. Knowledge of the hydraulic characteristics of basal aquifers and the nature of the stream-aquifer interdependence is needed in order to estimate safe and tolerable limits for development of ground water in such areas.

Compliance with the Federal Safe Drinking Water Act (PL 93-529, 1974) is having a pronounced effect on managerial and planning decisions, especially in areas where both ground water and surface water sources are available for municipal supplies. The high cost of treating surface water supplies must be weighed against the cost of developing ground water supplies.

7. ALTERNATIVE SOURCES OF SUPPLY

Development of Small Water Sources. There has been a tendency for large water users to delay the development of small water sources, the primary reason being the difficulty or infeasibility of assimilating scattered small supplies into existing distribution systems. Nevertheless, in view of the pressing need, development of many excellent small sources available in windward Oahu, the Waianae area, and the southeastern end of Oahu should be seriously considered.

Restoration of Dike-Impounded Storage. There is a general lack of man-made storage to meet summer peaking needs, and the prospects of significantly increasing the storage are negligible. Because of inadequate storage, summer peaking needs are now met by increased ground water pumping. This method is undesirable because excessive pumping leads to seawater contamination of basal aquifers that are the principal sources of supply.

Some of the summer peaking needs could be met by restoring dike-impounded storage lost by tunneling. The development of water stored elsewhere at high levels could also probably be utilized for summer periods of high demand. This scheme would make it possible to reduce somewhat the extremely heavy summer pumping from basal aquifers.

A study is now being conducted by the U.S. Geological Survey in cooperation with the Honolulu Board of Water Supply to evaluate the major dike-impounded ground water bodies on Oahu.

Exchange of Low and High Quality Water. Low quality treated sewage effluent or brackish ground water might be substituted in irrigation and industrial uses for water of domestic quality now being used for these purposes. Water shortage problems in areas where sugarcane is heavily irrigated could be relieved somewhat by similar water exchange practices. Large amounts of nonpotable water are available from treated sewage and from ground water in coastal sediments.

Brackish water from thin basal lenses and coastal sediments is presently being used for irrigation in a few areas of the state. Hotels and development projects on the dry leeward coasts of Hawaii and Maui pump brackish water from shallow coastal wells to irrigate golf courses and other greenery. Ground water from coastal sediments is used for irrigation and other nonpotable uses in some parks on Oahu.

Planning for future wastewater management should focus on reuse. Table 8 lists existing and proposed sewage treatment plants from which treated effluent can be diverted for reuse elsewhere.

Wastewater Reclamation. Reclamation (i.e., treatment of domestic or irrigation wastewater to levels suitable for domestic or lower uses) might be feasible in highly populated areas where fresh water supplies are limited and wastewater is plentiful. By collecting domestic and agricultural wastewater and treating to levels suitable for irrigation and industrial uses, demands for new fresh water supplies can be substantially reduced.

Potential opportunities for reuse of treated wastewater include the following applications: (1) irrigation of certain crops and forage, (2) aquaculture, (3) ground water recharge, (4) toilet flushing and lawn irrigation (in dual water supply systems), (5) enhancement of fish and wildlife habitats, and (6) industrial cooling and processing purposes. Because of

plant location, undesirable effluent quality such as might result from excessive sea water infiltration into sewers, or other technical reasons, not all effluent from treatment plants are reclaimable in practice. Estimated quantities of effluent available from existing sewage treatment plants with potential for effluent reuse are given in Table 8.

While the potential for reuse of treated wastewater is considerable, problems do exist. Some of them are: (1) intensive energy, capital, and operation and maintenance requirements for most applications, (2) potential problems with viruses, bacteria, and parasites, (3) build-up of undesirable salts in the soil and possible contamination of the underlying aquifer, (4) expensive pumping and piping in certain situations, and (5) conflicts in water rights and water use allocation.

Blending Fresh and Brackish Water. Fresh and slightly brackish water can be blended to produce an augmented supply of domestic-quality water. Blending fresh and more brackish water can produce a supply suitable for irrigation. At Lahainaluna and Kanaha on Maui and at Kawaihae on Hawaii, slightly brackish ground water is used to supplement the surface water supply.

Desalting Brackish Water. Desalting brackish ground water might meet increasing requirements in water-short areas in Hawaii, especially coastal areas where brackish water abounds. Methods for desalination fall into three general categories: (1) phase change, (2) membrane separation, and (3) chemical reaction.

In Hawaii, there are large quantities of brackish water where fresh and saline ground waters mix. Being of relatively low salinity (generally less than 3,000 parts per million total dissolved solids compared with 35,000 ppm for seawater), this brackish water can be treated more economically than seawater. It is particularly well suited to desalination by membrane

Table 8. EXISTING WASTEWATER TREATMENT PLANTS WITH POTENTIAL FOR EFFLUENT REUSE

Name of Plant	Plant Capacity (mgd)
COUNTY OF HAWAII	
Keauhou Bay	1.0
Kailua-Kona	1.0
Boise Cascade	0.25
Mauna Kea Beach Hotel	0.25
COUNTY OF MAUI	
Lahaina	3.2
Wailuku-Kahului	6.0
Pukalani Terrace	0.2
Kihei	4.0
Kaunakakai	0.6
CITY & COUNTY OF HONOLULU	
Kahaluu (Ahuimanu)	1.4
Waimanalo	1.1
Hawaii Kai	3.1
Honouliuli	25.0
Mililani	3.6
Schofield	1.64
Wahiawa	2.5
Whitmore Village	0.2
NCS (U.S. Navy)	0.3
Halemano	0.5
Waipahu	3.6
Makakilo	1.3
Nanakuli	0.12
Pacific Palisades	0.67
COUNTY OF KAUAI	
Wailua	0.5
Koloa-Poipu	0.15
Hanapepe-Eleele	0.4
Waimea	0.4
Lihue	0.5

Source: Department of Health

separation, in which process energy requirements are dependent upon the amount of salts to be removed.

Desalting operations are comparatively expensive and require significant quantities of energy. A 1974 study investigating the engineering and economic feasibility of desalting plants in Hawaii concluded that it is unlikely that desalting low salinity ground water will be economically attractive in Hawaii as long as fresh water supplies are available for transport, except possibly in isolated or unusual circumstances.

This conclusion was based primarily on the economic disadvantages then associated with desalting plants when compared with conventional surface water developments. In the near future, because of intensifying water demands and the relatively fixed natural supplies of fresh water, it is likely that desalting will become significant in areas of high demand, such as Oahu.

Presently, a brackish water desalting unit is used by the Kona Village Resort on Hawaii for its potable water requirements.

Because of the advances being made in technology, especially in membrane separation processes well suited to Hawaiian conditions; rapid increases in power, equipment, and construction costs; and changes in water quality standards required by the Safe Drinking Water Act, desalting as an alternative source of water supply should be reexamined when the need for such supply is imminent and should be based on economic and social evaluations of alternatives for the specific conditions of problem areas.

Desalting Seawater. Desalting seawater, like desalting brackish water, is techincally feasible, but numerous studies have shown that the cost of desalting seawater to be 2 to 3 times as much as desalting brackish waters. Proposals have

been made to reduce the cost of seawater desalting by using the waste heat from electric power generation as the source of energy for seawater distillation, but sufficiently large demands for electric power must exist to justify installation of the large power generation station required to allow the dual-purpose concept to approach economic viability. None of the islands presently has such sufficiently high power demands. Under this circumstance, the desalting of brackish ground water sources would be a preferred alternative to desalting seawater.

There is a possibility, engendered by the recent pioneering effort of the federally-sponsored OTEC (Ocean Thermal Energy Conversion) project on the island of Hawaii, that water of potable quality may be obtainable in promising quantities as a by-product of the energy conversion process. This possibility should be explored for its potential as another alternative means to augment the state's present supplies of potable-quality surface and ground waters.

Surface Water Impoundment/Recharge, Pearl Harbor Basin. A recent study conducted to determine the feasibility of surface water impoundment/recharge on Oahu (R.M. Towill Corporation, September 1978) concluded that a diversion dam/recharge system in a typical stream valley in the Pearl Harbor basin should be seriously considered in order to preserve the Oahu basal water system for continued supply of excellent quality water to the City of Honolulu and its environs.

The study suggested that a pilot recharge well 16 to 20 inches in diameter be drilled and actual streamflow recharged into the pilot well to determine recharge rates and clogging characteristics. Field tests consisting of small bore holes and seismic surveys and/or resistivity soundings were recommended to position the pilot recharge well.

C. Problem Analysis and Recommended Objectives

In general, Hawaii's water supply problems are not due to lack of rainfall, but to disparities in rainfall distribution. Although there is wide fluctuation in daily, monthly, seasonal, and annual amounts; uneven distribution over windward and leeward areas; and considerable loss of water by immediate runoff where the terrain is steep and the ground surface impervious, rainfall is sufficient to supply the present and foreseeable future water requirements of all the major islands, with the possible exception of Oahu, where continued usage under present trends may result in a shortage of developable freshwater supplies before the turn of the century.

Comparison of water supply and water use data shows that water resources on each island generally are sufficient to meet water needs for all purposes. However, there are local problems of varying intensity on nearly all of the islands. These problems include shortages resulting from poor distribution of supplies, limited capital to fund development projects, instream-offstream water use conflicts, competition among various users, ground water overdraft, quality degradation of both surface water and ground water, and institutional conflicts that prevent a unified approach to water management. These problems and recommended solutions are discussed in the following sections.

1. MUNICIPAL WATER

Situation

Generally, all islands have sufficient municipal water to meet the demand for the 1980-2000 period, except Oahu, where projected demand will begin to tax the sustainable yield of fresh water from presently developed sources by about the year 2000 (see Figure 7 and Table 9). There are one or more water-short areas with the potential for more productive development on all major islands.

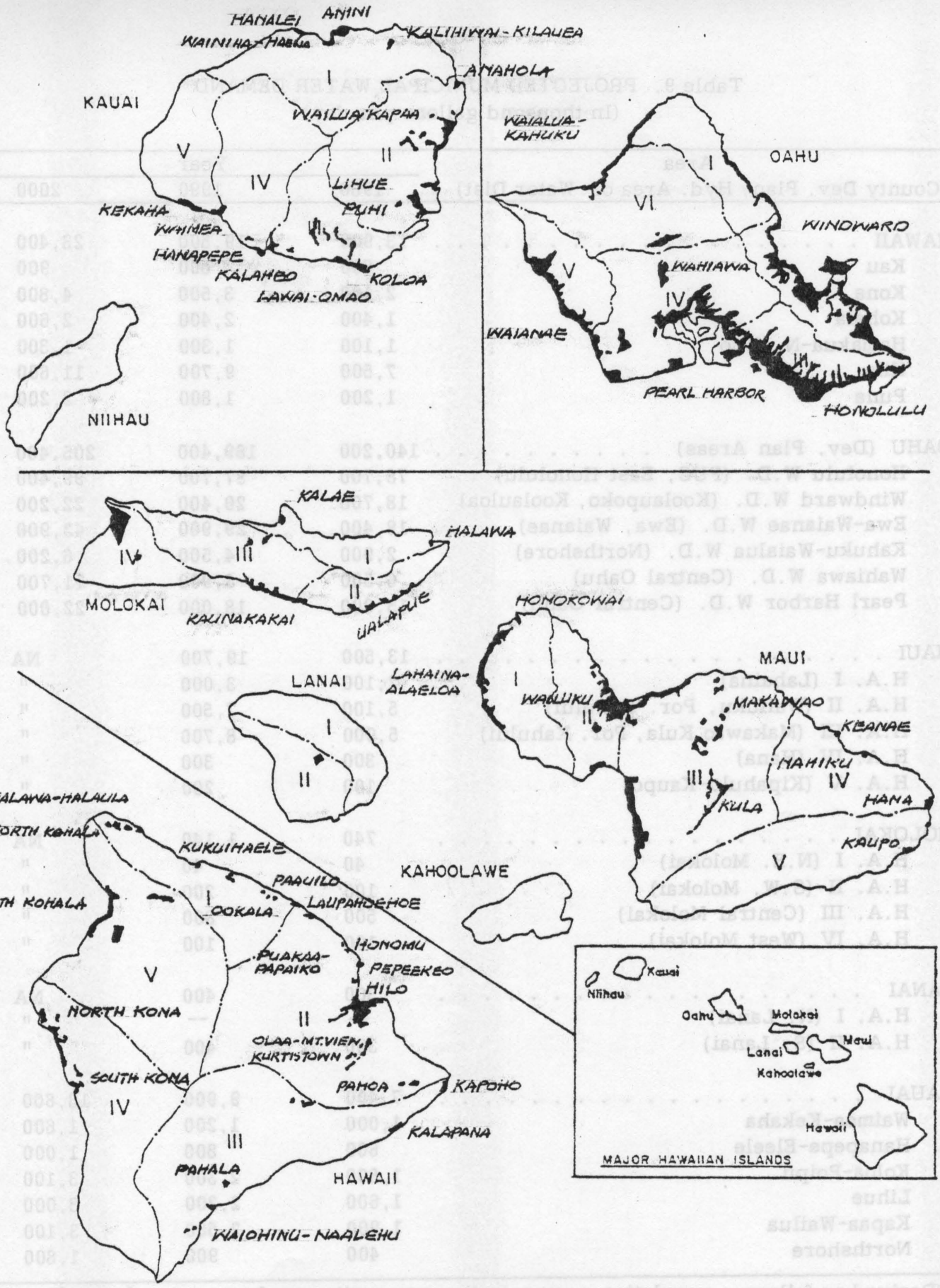


Figure 7. MUNICIPAL WATER SYSTEMS

Table 9. PROJECTED MUNICIPAL WATER DEMAND*
(In thousand gallons per day)

Area (County Dev. Plan, Hyd. Area or Water Dist)	Year 1980	1990	2000
HAWAII	13,900	19,500	23,400
Kau	600	800	900
Kona	2,100	3,500	4,800
Kohala	1,400	2,400	2,600
Hamakua-N. Hilo	1,100	1,300	1,300
Hilo	7,500	9,700	11,600
Puna	1,200	1,800	2,200
OAHU (Dev. Plan Areas)	140,200	169,400	205,400
Honolulu W.D. (PUC, East Honolulu)	78,700	87,700	99,400
Windward W.D. (Koolaupoko, Koolauloa)	18,700	20,400	22,200
Ewa-Waianae W.D. (Ewa, Waianae)	18,400	29,900	43,900
Kahuku-Waialua W.D. (Northshore)	2,900	4,500	6,200
Wahiawa W.D. (Central Oahu)	6,500	8,900	11,700
Pearl Harbor W.D. (Central Oahu)	15,000	18,000	22,000
MAUI	13,500	19,700	NA
H.A. I (Lahaina)	2,100	3,000	"
H.A. II (Wailuku, Por. Kahului)	5,100	7,500	"
H.A. III (Makawao,Kula, Por. Kahului)	5,900	8,700	"
H.A. IV (Hana)	300	300	"
H.A. V (Kipahulu-Kaupo)	100	200	"
MOLOKAI	740	1,140	NA
H.A. I (N.E. Molokai)	40	40	"
H.A. II (S.W. Molokai)	100	200	"
H.A. III (Central Molokai)	500	800	"
H.A. IV (West Molokai)	100	100	"
LANAI	300	400	NA
H.A. I (N. Lanai)	--	--	"
H.A. II (S. Lanai)	300	400	"
KAUAI	7,400	9,900	13,600
Waimea-Kekaha	1,000	1,200	1,600
Hanapepe-Eleele	600	800	1,000
Koloa-Poipu	1,600	2,300	3,100
Lihue	1,600	2,200	3,000
Kapaa-Wailua	1,900	2,500	3,100
Northshore	400	900	1,800

*Derived as follows: population x consumption per capita per day = water demand

Pumping from ground water sources is generally within the limits of sustainable yield. A critical problem of overdraft could occur in some aquifers, however. This may be the fate of the Pearl Harbor aquifer on Oahu if additional water development is undertaken without compensating conservation measures.

One consequence of limited sources of fresh water is an incremental increase in the cost of developing water systems. For example, less accessible sources are more expensive to reach; desalination of brackish water is relatively costly. Another consequence is the environmental impact of development. For example, diverting streamflows might disrupt the natural habitat of certain aquatic species; excessive pumping of ground water might degrade basal aquifers by causing salt water intrusion.

Recommended Objectives

A series of recent developments have brought water supply issues to the highest level of government and public interest. Increases in water use by a growing population, the 1978 amendments to the Hawaii Constitution, legislative emphasis upon the quality of life and effective environmental management, the need for new investment in water facilities, and federal safe drinking water standards all contribute to this heightened concern over water supplies.

These issues are epitomized by the water supply situation on Oahu, where water demand is rapidly approaching the estimated sustainable yield of developed sources. The 1976-1977 drought, during which Oahu experienced its driest winter in history, caused acute islandwide concern. Conservation measures were undertaken, and the Honolulu Board of Water Supply promulgated drought regulations to minimize water use. Although the crisis eased with the end of the drought, the effect will be indelible, since water supply management policies were brought under critical scrutiny.

Functional Plan objectives for municipal water development stemming from and consistent with the broader goals and objectives of the Hawaii State Plan are recommended as follows:

Objective A: ASSURE ADEQUATE MUNICIPAL WATER SUPPLIES FOR PLANNED URBAN GROWTH.

Basis. Population growth, increasing per capita use, and expanding economic activity will strain many existing municipal water systems in the years to come. Effective measures must be implemented to avoid serious shortages of water service for island communities. Some potential water shortages may not be apparent, while others are likely to develop in certain areas. These shortages are generally due to source, storage, and distribution facilities with insufficient capacity to meet peak demands; deterioration in the quality of the water source; lag in planning water supply projects; and limited financing for new developments.

Some counties have access to reserves of surface or ground water adequate to meet their needs for the foreseeable future. Other counties, notably Honolulu, in order to avoid shortages, must either utilize sources requiring more complicated and costly development; or institute measures to reduce per capita consumption and reduce water wastage; or resort to unconventional sources of supply such as reuse, desalting, blending, etc.; or deliberately control growth. On Oahu, the most serious water supply problem in the future will likely be maintaining ground water quality notwithstanding increased pumpage.

Considerable investments must be made for improving water services. Costs are substantial for new source developments, storage reservoirs, transmission mains, and distribution pipelines.

State involvement in municipal water supply development has for many years been confined to the provision of planning, design, and construction assistance on the Neighbor Islands, where capital requirements for water facilities have been beyond the fiscal capacity of the counties. State projects have dealt principally with the development of water sources and ancillary transmission works; projects involving distribution facilities (tanks, pipelines, etc.) have been handled almost entirely by the counties.

While there is general agreement that municipal water supply service is primarily a county function and that, ideally, county water systems should be self-supporting, it is also agreed that there is compelling justification for financial assistance by the state and federal governments. What is needed is a better means to coordinate the granting of financial support to the counties.

Objective B: SUPPORT LONG-RANGE MUNICIPAL WATER SUPPLY PLANNING BY THE COUNTIES.

Basis. The two principal functions of municipal water systems, development of water sources and distribution of the water supply, have traditionally been the responsibilities of the counties. Through water master plans, the counties have provided continuing attention to the needs of the respective islands. However, to cope with increasing pressures from the various water users, planning procedures may need to be modified.

Specifically, water planning should be integrated with land use planning and planning for other purposes. How land is to be used will largely determine where and how much water will be demanded and for what purposes. For example, decisions made by county planning departments in preparing land

use plans for residential subdivisions, resort complexes, irrigated agriculture, and other purposes will determine whether or not and the extent to which water supplies will have to be developed to serve the intended uses.

Coordinating county municipal water plans with county general plans and more specific development plans, as well as this State Water Resources Development Functional Plan, will greatly enhance procedures for authorizing and funding new water supply projects and programs.

Policy:

(a) Augment long-range county planning for municipal water supply development.

Recommended Actions:

(a) Require the preparation of municipal water supply plans by the counties as a condition of future state financial assistance for county water programs and projects.

(b) Consider appropriation of state funds for county water planning consistent with this State Functional Plan on Water Resources Development.

Objective C: PROMOTE MUNICIPAL WATER CONSERVATION.

Basis. Objectives of water conservation are to avert critical water shortages and to obtain optimum use from existing supplies. If improved management and technology can reduce withdrawals while providing the same level of service, the efficiency of water use can be increased. Although potential improvements in water management and technology are limited by costs and other factors, economically feasible conservation efforts can immediately be directed toward reduction of water requirements with present technology. For example:

(a) Leakage from water systems can be reduced through a systematic program to detect and correct leaks. System losses exceeding 15 percent in many water systems can be reduced to about 10 percent, considered an acceptable loss level under reasonably good system management.

(b) Conservation education can result in the reduction of per capita consumption of municipal water. The recent drought campaign by the Honolulu Board of Water Supply achieved significant cutbacks in municipal water use. However, to be effective in the long run, conservation education should not be confined to periods of critical shortages; a continuing program should be designed to change basic attitudes. The public should better understand the full scope of water supply problems, the alternatives available to meet increasing needs, and the project costs of these alternatives.

(c) Water pricing can be effective in reducing water use. Typically, unit water rates decrease with increasing usage. If unit water rates were to escalate with increasing consumption, there would be a financial incentive for individual conservation. The Honolulu Board of Water Supply recently abandoned declining rates in favor of a uniform rate regardless of the amount of water used.

(d) Water conservation devices such as shower flow controls and toilet inserts can also reduce per capita water demand. Such devices have proven to be economic, acceptable to consumers, and highly effective. The City and County of Honolulu has taken a first step in this water conservation effort, amending its plumbing code to require water conservation devices on all new installations commencing November 1979.

Implementation of the above measures, singly or in combination, can help to meet the conservation policies of the Hawaii State Plan.

Objective D: IMPROVE DRINKING WATER QUALITY.

Basis. The Federal Safe Drinking Water Act of 1974 (P.L. 93-523), which brings municipal and private domestic water systems under state surveillance, requires comprehensive water sampling and monitoring to assure that water supplies meet standards established by the U. S. Environmental Protection Agency and the respective administering agencies at the state level. There are approximately 173 public water supplies in the State of Hawaii, each supplying 25 or more people that are subject to the conditions of the Act. Of these systems, 99 are owned and operated by government entities and 74 are privately owned. Some systems rely on surface waters which often are subject to microbiological contamination and undesirable turbidity. These conditions are most prevalent during periods of heavy rainfall.

In order to construct treatment facilities needed to meet drinking water standards, suppliers are often faced with high capital improvement costs. According to the Act, these costs must be passed on to the consumers. Because of this burden to the resident population, assistance is needed from both the state and federal governments. The counties, being responsible for municipal water supplies, are mandated to modify distribution processes despite limitations on their fiscal capability. The federal government should seriously consider providing grants to domestic water suppliers to upgrade water facilities.

Costs to upgrade water systems for compliance with the standards are estimated as follows:

	Municipal	Private	Total
Oahu	640,000	56,920	696,920
Maui	13,000,000	309,013	13,309,013
Kauai	789,000	454,650	1,243,650
Hawaii	4,070,000	243,100	4,313,100
	$18,499,000	$1,063,683	$19,562,683

Objective E: UPGRADE RURAL WATER SYSTEMS.

Basis. Many small rural water systems are approaching the end of their useful life and will require extensive renovation or reconstruction in order to continue to supply even a minimum of service. The prohibitive cost of upgrading small plantation systems may accelerate an already growing tendency to close plantation housing. This will shift the burden of domestic water service to municipal water systems operated by the counties.

The Federal Safe Drinking Water Act specifies standards that many rural and small community systems cannot presently meet. Also, where rural water systems rely on surface sources, especially base flow diversions, lack of adequate storage facilities accentuates the impact of droughts.

Upgrading the systems would require the replacement of deteriorated pipelines, tanks, and intake structures. But because these rural systems serve relatively small numbers of users and do not have the economic advantages of larger systems, they would have difficulty in financing established quality and operational requirements from water revenues.

2. WATER FOR AGRICULTURE

Situation

There are 297,000 acres of cropland in Hawaii. Sugarcane is grown on 221,000 acres, pineapple on 47,000 acres, and diversified crops on 29,000 acres. Agricultural water use in 1975 amounted to about 970 million gallons daily. (See Figure 8). About half of the sugarcane acreage is irrigated, accounting for 91 percent of the total agricultural water consumption. Pineapple, which is grown in drier areas, still relies mostly on rainfall. Principal diversified crop acreage

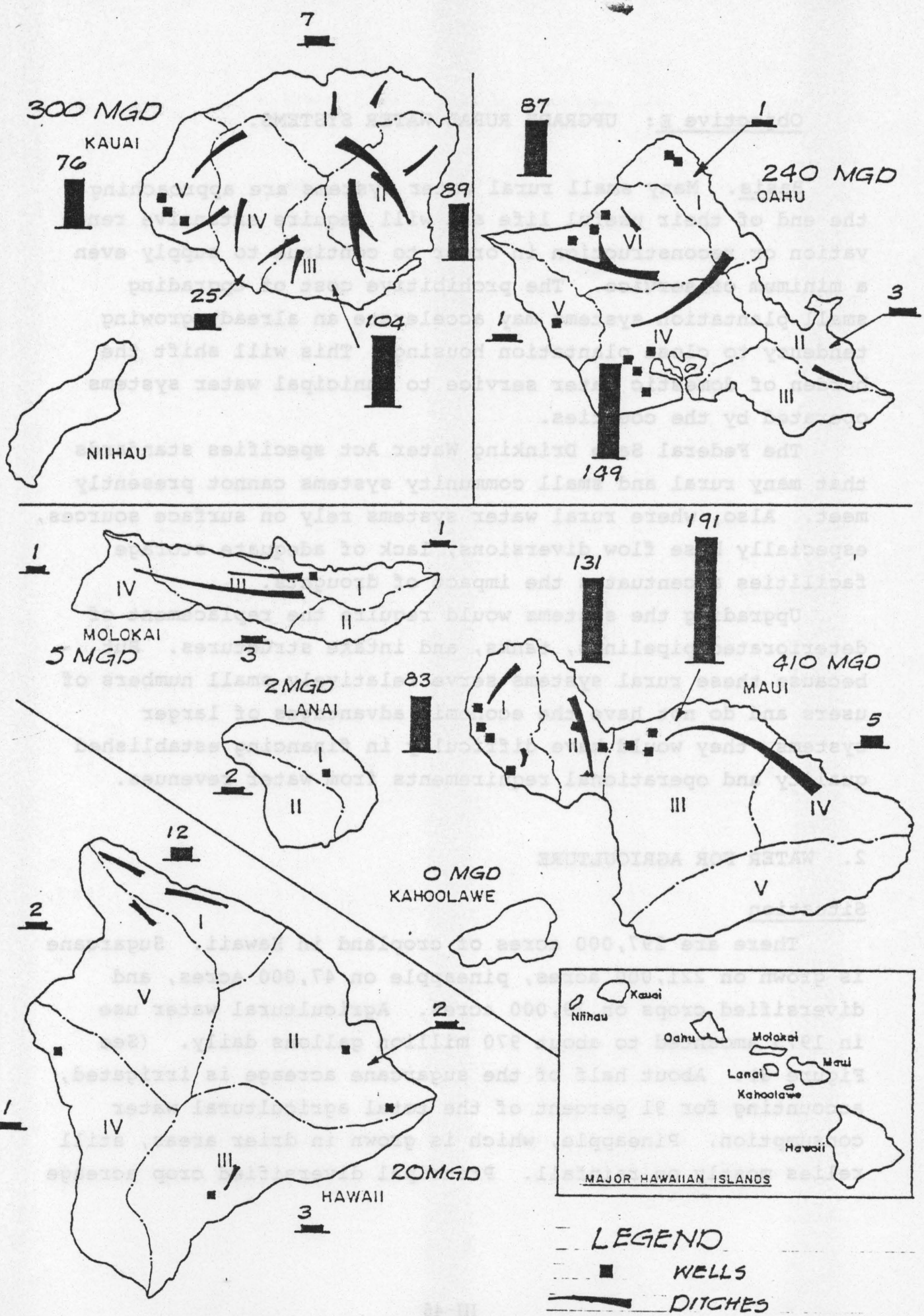


Figure 8. AGRICULTURAL WATER USE (MGD, 1975)

Source: Water Use Survey, 1975, U.S. Geological Survey

under State irrigation systems are at Lalamilo (310 acres), Hoolehua (145 acres), and Waimanalo (1,000 acres). On Maui, irrigation water for the Kula area is supplied from the county municipal system.

Future agricultural water requirements for sugarcane and pineapple will probably remain the same. Diversified crops are expected to double present requirements.

Sugarcane Production. Sugarcane is irrigated on 122,000 of the 221,000 acres in production (Table 10). It uses about 880 mgd, the largest water user in the state. Irrigation requirements for sugarcane depend on climate. Where average yearly rainfall exceeds 75 inches, the crop usually is not irrigated.

Total water requirements, including rainfall and irrigation supplies, average 85 percent of pan evaporation. In dry areas such as Ewa and Central Maui, where evaporation ranges from 80 to 100 inches yearly, total water requirements vary from 5,000 to 10,000 gpd per acre.

The use of more efficient irrigation methods not only saves water but can increase yields per acre. By substituting drip for furrow irrigation, deficits could be eliminated in some areas; sugarcane acreage could be increased by 20 to 30 percent with present irrigation supplies; or the surplus water could be used for other purposes.

Furrow irrigation is about 50 per cent efficient, sprinkler 80 percent, and drip 90 percent. Losses from water transmission through open ditches and storage in unlined reservoirs add materially to the total water supply needs in some areas using surface water. These losses are usually economically unavoidable.

Table 11 shows water used for sugarcane irrigation by the various application methods in 1975.

Pineapple Production. The 48,000 acres of pineapple grown in Hawaii in 1976 were distributed as follows: Oahu 16,000 acres, Maui 12,000, Lanai 15,000, and Molokai 5,000.

Table 10. IRRIGATED SUGARCANE ACREAGE, 1977

Plantation	Unirrigated	Irrigated				Total Acreage
		Furrow	Overhead	Drip	Total	
Oahu Sugar Company, Ltd.	44	15,575	--	3,247	18,822	18,866
Waialua Sugar Company, Inc.	2,735	8,416	719	3,481	12,616	15,351
Hawaiian Commercial & Sugar Co.	--	19,807	3,562	9,517	32,886	32,886
Pioneer Mill Company, Ltd.	--	6,743	154	2,283	9,180	9,180
Wailuku Sugar Company	--	1,350	--	4,112	5,462	5,462
Hilo Coast Processing Company	24,920	--	--	--	--	24,920
Honokaa Sugar Company	11,215	--	4,629	872	5,501	16,716
Ka'u Sugar Company, Inc.	16,582	--	107	--	107	16,689
Laupahoehoe Sugar Company	17,520	--	1,380	--	1,380	18,900
Puna Sugar Company, Ltd.	15,859	--	--	--	--	15,859
Gay & Robinson	--	2,246	--	429	2,675	2,675
Kekaha Sugar Company, Ltd.	--	6,913	168	798	7,879	7,879
The Lihue Plantation Co., Ltd.	5,852	11,371	--	186	11,557	17,409
McBryde Sugar Company, Ltd.	4,485	6,378	--	2,248	8,626	13,111
Olokele Sugar Company, Ltd.	--	1,957	--	2,869	4,826	4,826
TOTAL	99,212	80,756	10,719	30,042	121,517	220,729

Source: HSPA

Table 11. WATER USED FOR SUGARCANE IRRIGATION, 1975
(mgd)

	Furrow	Sprinkler	Drip	Total
Hawaii	6	1	--	7
Maui	369	18	17	404
Oahu	188	3	14	205
Kauai	251	2	10	263
Total	814	24	41	879

Source: Water Use Survey, 1975, USGS.

Pineapples are suited for cultivation under semi-arid conditions, about 25 to 35 inches of rainfall annually. Pineapple irrigation by sprinkler and drip methods used a total of 4 mgd in 1975. While water needs are now comparatively small, being met mostly by rainfall even in the drier areas, increased use of drip irrigation is expected. Water needed for pineapple is roughly one-ninth that required for sugarcane.

The state government's Molokai Irrigation System provides adequately for pineapple irrigation at Hoolehua. On Oahu and Maui, most of the water used for pineapple irrigation is derived from cane irrigation systems. New production in Kula is being served from the county's municipal system. Lanai's water supplies are shared by all users.

Diversified Agriculture Production. Enhancement of diversified agriculture production is supported by state administrative policy and legislative policy expressed in the Agricultural Park Law and the Hawaii State Planning Act.

Past state involvement in agricultural water supply has been confined to the development and operation of water systems serving specially formed irrigation districts. Except for those served by state irrigation systems, diversified farmers must either rely on their own water systems or, usually, upon municipal water systems operated by the respective county departments of water supply. The counties furnish irrigation water for diversified agriculture as an accessory, nonmandated service at rates only slightly lower than domestic rates.

There are 460 acres of taro and 36 acres of watercress grown in Hawaii today. Major taro growing areas are Hanalei on Kauai, Windward Oahu, Keanae on Maui, and Waipio on Hawaii. The Pearl Harbor area grows most of the watercress. Water requirements for taro is estimated at .05 million gallons per acre daily. In 1976, taro used 6,257 mg, or .04 mgd per acre. Watercress growers estimate their needs at 1 million gallons per acre daily. In 1976, watercress used 814 mg, mostly ground water, equivalent to .06 mgd per acre.

Taro and watercress, both high water users, are gradually losing the competition for Oahu's water supplies. The Hawaii Supreme Court has affirmed that appurtenant kuleana water rights entitle taro lands to the amount of water required to raise a successful crop in the 1840's, unless these rights have been sold or leased.

The State Functional Plan for Agriculture promotes agricultural parks for at least eight different areas in the state (Figure 9). Its policy requires adequate water needs for these parks.

Water requirements for these parks have been estimated on the basis of possible land use and weather conditions. (See Table 12).

Water for Pahoa, Panaewa, and Ke'ahole probably will be obtained from municipal water systems; Waimanalo, Kilauea (Kauai), and Lalamilo, from streams; and Waianae and Kahuku, from wells.

Although there are farm areas that lack an adequate water supply, diversified agriculture generally is equally concerned with the cost of water, as well as its availability.

Measures that might be taken to overcome problems associated with diversified crop production include the following:

(a) Where feasible, locate agricultural parks where water is available, and develop irrigation water to supply them.

(b) Where practicable, promote the development of agricultural water systems separate from domestic water systems.

(c) Use nonpotable water for agriculture where potable water is in short supply.

(d) Encourage wastewater reuse for irrigation; site new sewage treatment plants accordingly.

(e) Where the municipal water system is the only alternative available for diversified crop irrigation, endeavor to accommodate irrigation needs compatibly with domestic requirements.

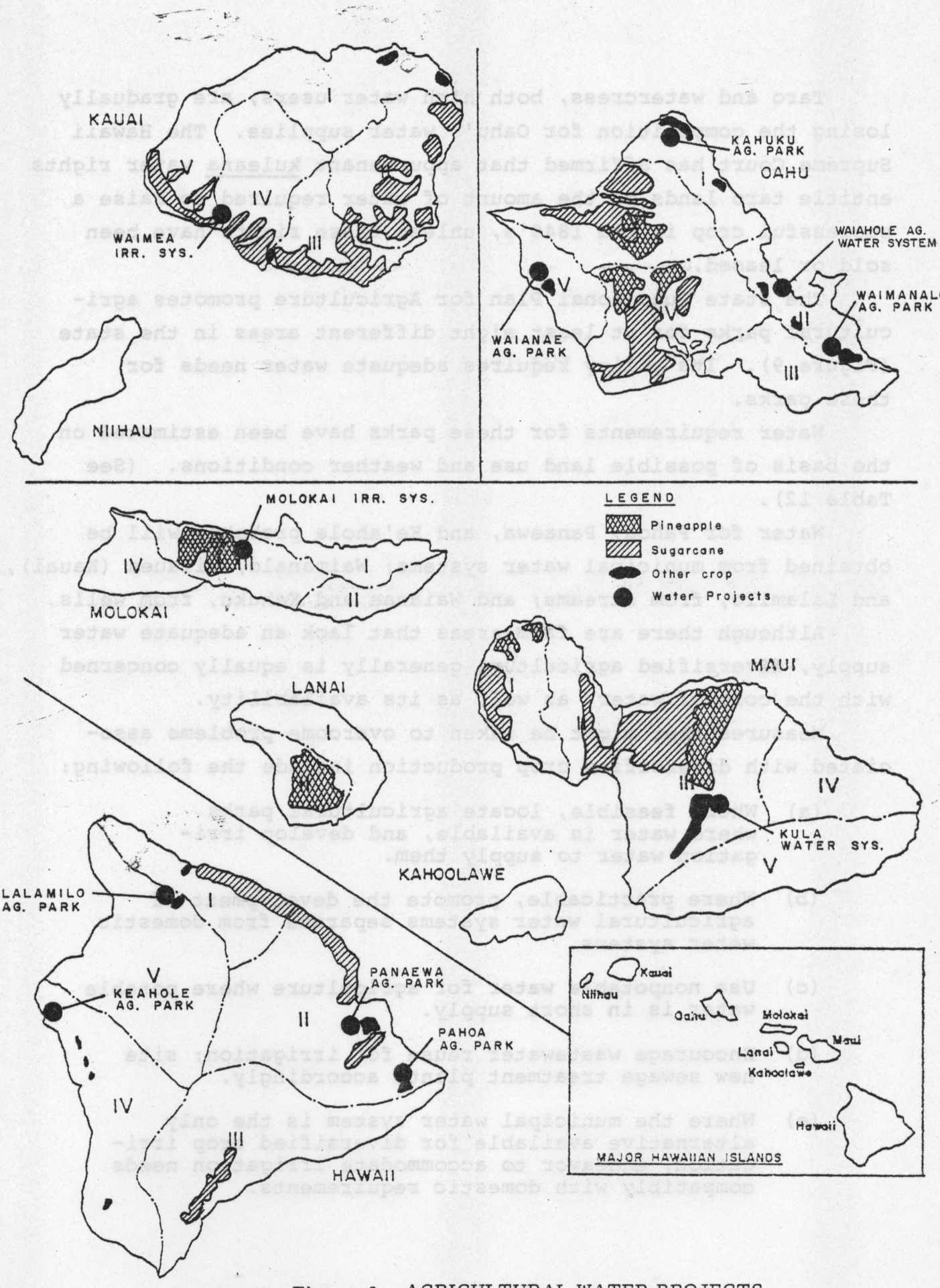


Figure 9. AGRICULTURAL WATER PROJECTS

Table 12. ESTIMATED WATER REQUIREMENT FOR PROPOSED AGRICULTURAL PARKS

Location	Acreage	Proposed Use	Estimated Water Requirement (gallons/day)	Water Source
Pahoa	410	Anthurium, Guava	Occasional	County system
Panaewa	270	Macadamia Nut, Nursery, Guave	"	"
Lalamilo	200	Truck Crop	700,000	Lalamilo State Irrig. System
Keahole	200	Nursery	700,000	County system
Waimanalo	1,800	Banana, nursery, Diversified Crops	1,500,000	Waimanalo State Irrig. System
Kahuku	3,000	Field crops, livestock	300,000	Well
Waianae	200	Dairy, Crops	100,000	Well

(f) Continue special rates for agricultural water from municipal systems at reasonable levels, subject to periodic review.

(g) Provide state grants to county water departments to subsidize the service of irrigation water for diversified agriculture from municipal systems.

(h) Consider the possibility of allocating water supplies for agricultural use based upon economic and water quality considerations, just as economics and soil quality are considered in delineating land districts for agricultural use.

Effect of Irrigation Return Water on Basal Aquifers. As previously mentioned, irrigation requirements are greater than for any other water use. The availability of irrigation water supplies directly affects the production of sugar, Hawaii's biggest export commodity.

The transfer of water from wet to the dry areas for irrigation has the effect of widening the area of ground water recharge from rainfall. Massive shifts from furrow irrigation to drip irrigation of sugarcane would cause changes in the hydrology of heavily irrigated areas now affected by ground water recharge.

Studies on the recharge effects of the return flow of sugarcane irrigation water in Hawaii indicate a definite build-up of minerals (chloride, nitrate, sulfate, silica) in the upper level of the receiving basal aquifer and the recycling of these mineral constituents in ground water supplies. It is also possible for very small quantities of herbicides to leach into ground water.

The likelihood of nitrate and sulfate leaching under some conditions and the remote possibility of some herbicides contaminating ground water suggest the need for management controls to maintain ground water quality. Periodic monitoring of selected wells would provide a safeguard against contamination by persistent organic compounds.

Recommended Objectives

Agricultural water development in Hawaii can be accelerated through the coordinated use of resources in accordance with the following recommended objectives:

Objective F: IMPROVE THE QUALITY, EFFICIENCY, SERVICE, AND STORAGE CAPABILITIES OF SYSTEMS SUPPLYING AGRICULTURAL WATER.

Basis. In those many areas where crop production is largely dependent upon irrigation, water is transported long distances from watershed to croplands, or inadequate surface water supplies are supplemented with ground water. Irrigated crop production in Hawaii has been and will continue to be limited by the volume and cost of available water supplies.

Objective G: INCREASE THE USE OF TREATED SEWAGE EFFLUENT AND OTHER NONPOTABLE WATER FOR IRRIGATION PURPOSES.

Basis. Because major discharges of wastewater must meet increasingly strict effluent standards imposed by the 1972 Federal Water Pollution Control Act, the 1977 Clean Water Act, and the updated Hawaii Water Quality Standards, the additional treatment required to make wastewater reusable for certain applications has been steadily decreasing.

This trend further justifies recycling of wastewater for productive use, such as irrigation of sugarcane and forage. Also, for certain applications, brackish water may be substituted for fresh water.

Objective H: PROMOTE AGRICULTURAL WATER CONSERVATION.

Basis. The recurrence of droughts and increasing demands upon water supplies dictate that measures be instituted to conserve water and energy. The following conservation practices should be considered:

(a) Improved irrigation application methods. Typical application efficiency of furrow irrigation is 50 percent; sprinkler irrigation, 80 percent; and drip irrigation, 90 percent.

(b) Improved irrigation scheduling. Efficient irrigation scheduling involves consideration of climate, soils, crops, and management factors. If any of these factors are misjudged, irrigation may be scheduled too often or not often enough.

(c) Improved weed control. Water losses due to weeds can be high, especially when water loving weeds are allowed to proliferate in open ditches or in poorly drained areas.

(d) Improved seepage control. Seepage is considerable from the many irrigation ditches in Hawaii that are unlined and age-old.

Objective I: PROVIDE ADEQUATE, REASONABLY PRICED WATER SUPPLIES FOR AGRICULTURAL PRODUCTION.

Basis. Present statutes require that operation and maintenance costs for state-owned irrigation systems be paid for by irrigation water charges; the recovery of capital costs is relaxed where hardship exists. In most instances, revenues generated have not been sufficient to cover the costs of operating and maintaining state irrigation systems. Increasing the price of water would not stimulate diversified agricultural production, which the state is aggressively promoting.

3. SELF-SUPPLIED INDUSTRIAL WATER

Situation

Industrial water supplies in Hawaii are provided both by county municipal systems and by private industrial systems. A few major industries provide their own water supplies, and the balance, mostly smaller businesses, rely on the municipal systems. The following discussion is concerned only with water supplies developed by the industries themselves, referred to as "self-supplied" industrial water.

Of the approximate 573 billion gallons of self-supplied industrial water used throughout the state in 1975, 77 billion gallons (13 percent) was used for sugar mill processing, 421 billion gallons (73 percent) was used primarily for thermoelectric cooling, and 75 billion gallons (13 percent) was used to generate hydroelectric power. Of the water used for cooling purposes by thermoelectric (oil-fired) power plants, 88 percent is seawater. (See Figure 10).

In 1975, the total public utility network in Hawaii totalled approximately 1,357 MW (megawatts). The hydroelectric power plants of Hilo Electric Light Company and the various sugar companies totaled 19 MW, or about 1.3 percent of the total. Table 13 compares the 1975 contribution of hydroelectric power to total private and public energy production by islands.

It is expected that future needs for major self-supplied industrial water would consist largely of increased requirements for electric power generation. Wash water used by the sugar mills, now largely recycled to the adjacent irrigated canefields, will continue to be utilized at present levels.

Although always important, current trends require greater consideration of energy consumption in a water utility's operation. The cost of energy has assumed an increasing percentage of water operating costs in recent years, and it will likely continue to increase in the foreseeable future. It may be well for water producers to evaluate their present water system operating procedures to determine modifications to those procedures or improvements to the physical system that will result in reducing energy consumption.

General guidelines frequently suggested for the most efficient pumping operations for existing facilities include the following:

1. Use the pump stations that operate against the lowest total heads, and deliver water to consumers by pumping the fewest times possible.
2. Anticipate the required daily pumpage and make efforts to meet demands with constant-rate pumpage combined with flow to and from storage.
3. Use the most efficient combination of pumps available at a given station to provide the required flow.
4. Ensure that all valves are completely open during pumping operations.
5. Avoid throttling or bleeding flow between pressure districts within the system.

As future additions are made, greater savings can be achieved through the judicious selection of equipment that will provide energy-efficient operations.

Water for Thermoelectric Cooling. Electrical energy consumption in Hawaii is expected to grow as shown in Table 14, which also indicates water requirements for thermoelectric cooling.

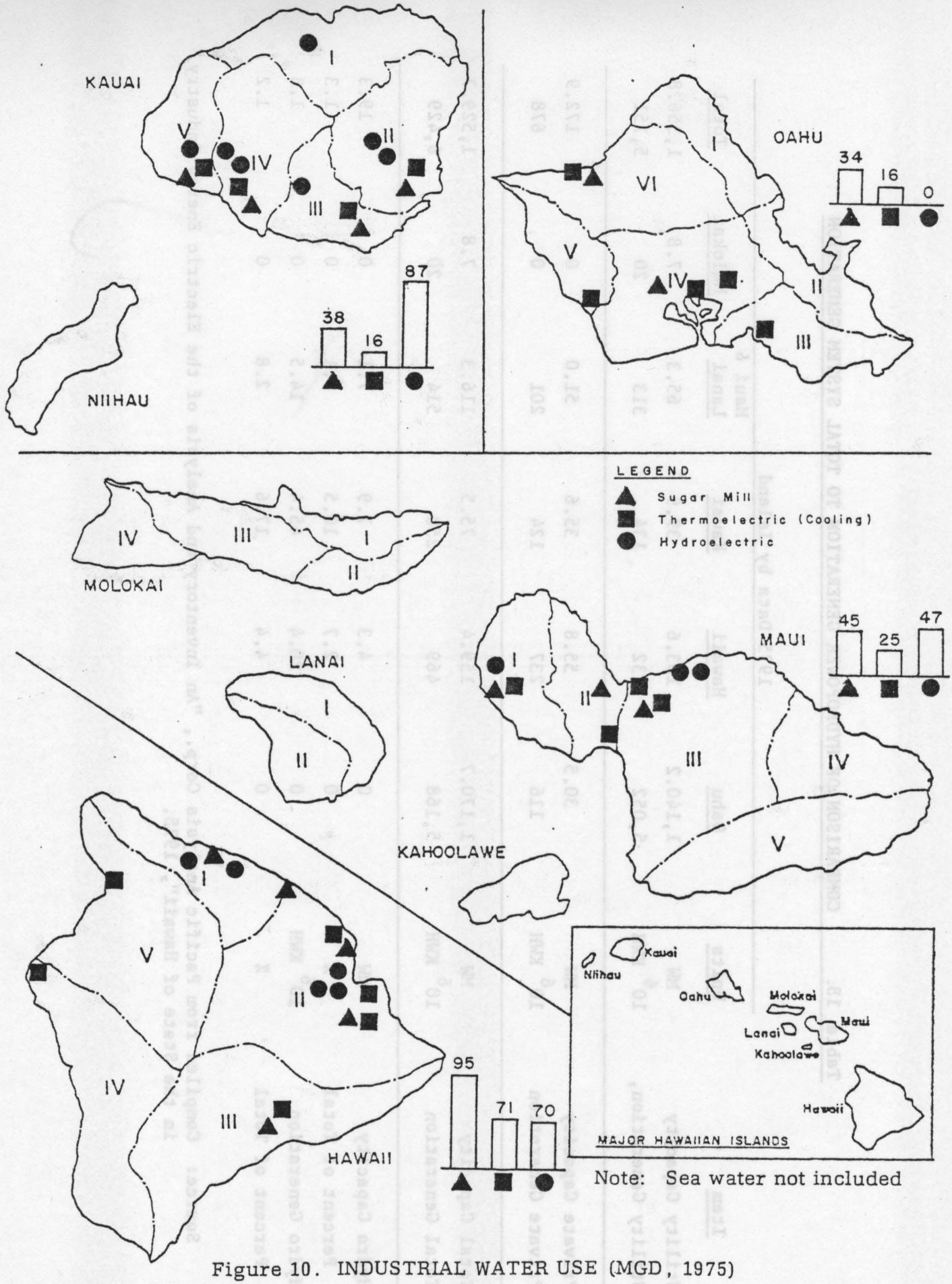


Figure 10. INDUSTRIAL WATER USE (MGD, 1975)

Source: Water Use Survey, 1975, U.S. Geological Survey

Table 13. COMPARISON OF HYDROPOWER GENERATION TO TOTAL SYSTEM GENERATION

Item	Units	1975 Data by Island					
		Oahu	Hawaii	Kauai	Maui & Lanai	Molokai	Total
Utility Capacity	MW	1,140.2	103.6	39.9	65.3	7.8	1,356.8
Utility Generation,	10^6 KWH	5,052	232	134	313	20	5,751
Private Capacity	MW	30.5	55.8	35.6	51.0	0	172.9
Private Generation	10^6 KWH	116	237	124	201	0	678
Total Capacity	MW	1,170.7	159.4	75.5	116.3	7.8	1,529.7
Total Generation	10^6 KWH	5,168	469	258	514	20	6,429
Hydro Capacity	MW	0	4.3	7.9	7.1	0	19.3
Percent of Total	%	0	2.7	10.5	6.1	0	1.3
Hydro Generation	10^6 KWH	0	20.4	45.4	14.5	0	1.3
Percent of Total	%	0	4.4	17.6	2.8	0	1.2

Source: Compiled from Pacific Analysis Corp., "An Inventory and Analysis of the Electric Energy Industry in the State of Hawaii", 1975.

Table 14. PROJECTED ENERGY CONSUMPTION AND COOLING WATER REQUIREMENTS, 1975-2000

Year	Projected Consumption* (Million kwh)	Cooling Water Requirement (mgd)**
1975	6,429	1,085
1980	8,400	--
1985	--	2,005
1990	15,900	--
2000	27,700	3,637

*Hydroelectric Power, Plan of Study, U.S. Army Engineer District, Honolulu, Hawaii, 1977

** The Nation's Water Resources (Second National Assessment), Prelim. Report, Vol. 2, Part III.

Table 15. HYDROELECTRIC POWER POTENTIAL AT SELECTED SITES
(As identified in "Draft Regional Report, National Hydropower Study, Hawaii Region", U.S. Army Corps of Engineers, Pacific Ocean Division, August 1980)

Name of Project	Owner	Power Potential Capacity MW	Power Potential Energy gwh	Type of Project
Island of Hawaii				
Union	Kohala Corp.	0.5	4.1	Rehabilitation
Papaikou Mill	Hilo Coast Processing Co.	0.13	1.0	Rehabilitation
Wailoa	--	2.9	12.3	New site (run of river)
Island of Maui				
Hamakua Ditch	Hawaiian Commercial and Sugar Co.	0.5	2.5	New site (run of river)
Hoopoi Chute	Hawaiian Commercial and Sugar Co.	2.0	3.0	New site (run of river)
Waihee	--	0.73	2.0	New site (run of river)
Island of Molokai				
Kualapuu Reservoir	State of Hawaii	0.09	0.55	Existing reservoir
Island of Oahu				
Wahiawa Reservoir	Waialua Sugar Co.	2.8	7.5	Existing reservoir
Island of Kauai				
Hydro Kaumakani	Olokele Sugar Co.	0.75	5.2	Existing plant
Wailua	--	10.1	21.7	New site (run of river)
Puulua Reservoir	Kekaha Sugar Co.	1.7	3.0	Existing reservoir
Waimea	Kekaha Sugar Co.	2.9	3.9	Existing plant
Alexander Reservoir	McBryde Sugar Co.	1.0	1.4	Existing plant
Kapaia Reservoir	Lihue Plantation Co.	0.12	0.2	Existing reservoir
Waialeale	--	3.9	42.7	New site (storage)
Hanalei	--	4.5	16.5	New site (run of river)
Kokee Water Project	--	10.0	29.2	New site (storage)

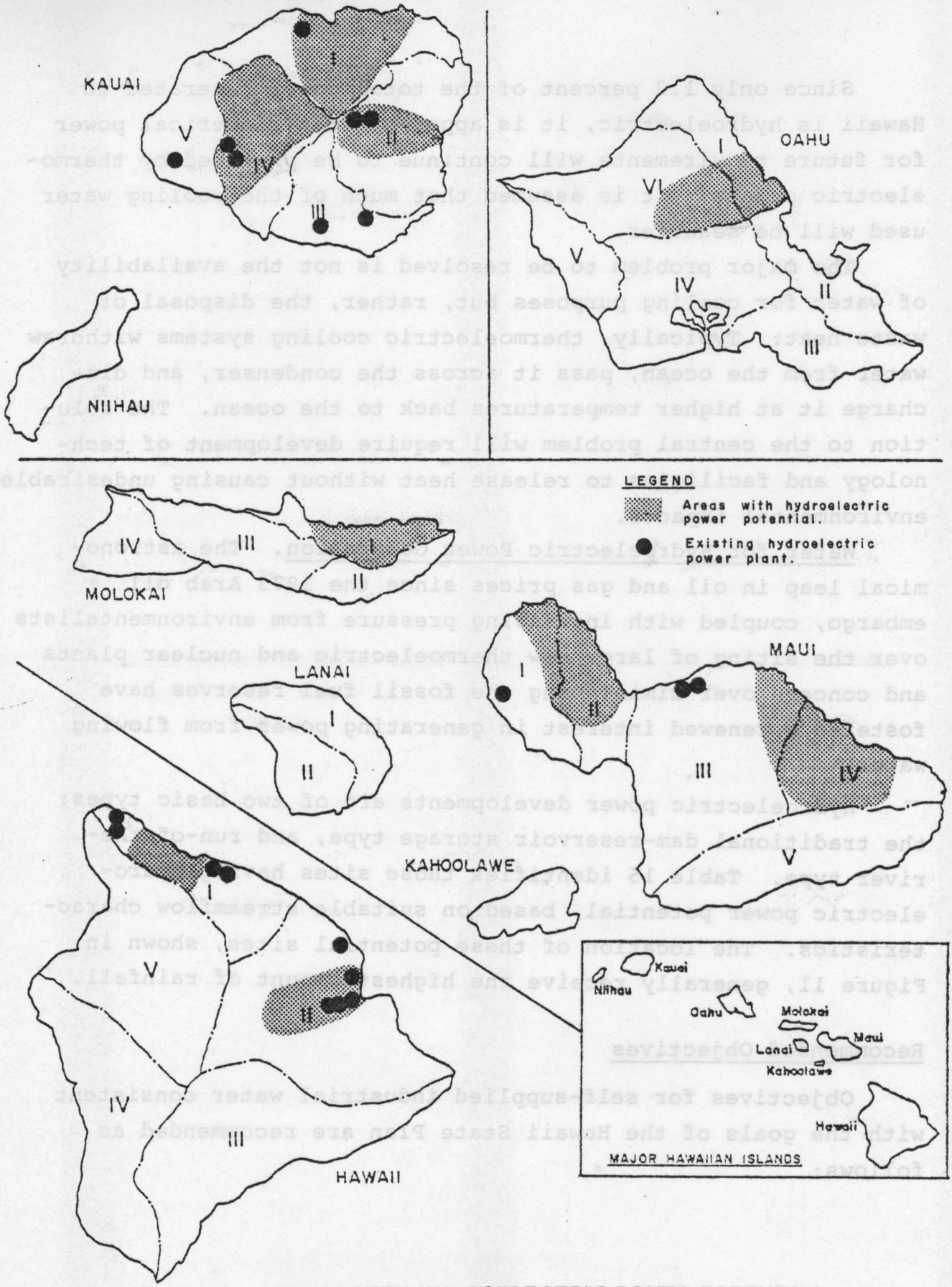


Figure 11. AREAS WITH HYDROELECTRIC POWER POTENTIAL

Since only 1.3 percent of the total power generated in Hawaii is hydroelectric, it is apparent that electrical power for future requirements will continue to be provided by thermoelectric plants. It is assumed that much of the cooling water used will be seawater.

The major problem to be resolved is not the availability of water for cooling purposes but, rather, the disposal of waste heat. Typically, thermoelectric cooling systems withdraw water from the ocean, pass it across the condenser, and discharge it at higher temperatures back to the ocean. The solution to the central problem will require development of technology and facilities to release heat without causing undesirable environmental impacts.

Water for Hydroelectric Power Generation. The astronomical leap in oil and gas prices since the 1973 Arab oil embargo, coupled with increasing pressure from environmentalists over the siting of large new thermoelectric and nuclear plants and concern over diminishing the fossil fuel reserves have fostered a renewed interest in generating power from flowing water.

Hydroelectric power developments are of two basic types: the traditional dam-reservoir storage type, and run-of-the-river type. Table 15 identifies those sites having hydroelectric power potential, based on suitable streamflow characteristics. The location of these potential sites, shown in Figure 11, generally receive the highest amount of rainfall.

Recommended Objectives

Objectives for self-supplied industrial water consistent with the goals of the Hawaii State Plan are recommended as follows:

Objective J: REDUCE THE ENVIRONMENTAL IMPACT OF WASTE HEAT DISPOSAL FROM THERMOELECTRIC POWER PLANTS.

Basis. Hawaii's ocean environment is well suited for diluting, dispersing, and dissipating waste heat from thermoelectric power plants. However, where waste heat disposal will adversely affect important aquatic life or other environmental values, permissible temperature levels will have to be established.

Objective K: DEVELOP WATER SOURCES FOR THE GENERATION OF HYDROELECTRIC POWER.

Basis. There is a potential for additional small hydroelectric power plants in Hawaii as an alternative to thermoelectric plants. Whereas thermoelectric energy rates are geared to escalating oil costs, hydroelectric power can be delivered at relatively stable prices. Hydroelectric power is a renewable nonpolluting alternate energy source and can be decentralized. There are potential sites for hydroelectric power plants in high rainfall areas on several of the islands.

4. INSTREAM USES OF WATER

Situation

There are many socially beneficial uses of water which entail damming or diverting water from streams. Among these uses are domestic consumption, agricultural irrigation, livestock watering, and industrial uses, including power generation. On the other hand, there are several socially beneficial instream uses of water. Instream uses include recreation, fish and wildlife habitat, aesthetic enjoyment, and maintenance of stream water quality.

Hawaii's laws do not specifically provide for the protection or preservation of water for instream uses. Problems can result from water development programs that do not adequately consider the need to leave sufficient water for instream use. In principle, a well conceived system for allocating water among beneficial instream and offstream uses would weigh the relative value of competing uses.

The Coastal Zone Management Act (Chapter 205A, HRS), establishes a policy to "minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization and similar land and water uses, recognizing competing water needs." Under the Environmental Policy Act (Chapter 344, HRS), it is state policy to protect recreational and aesthetic values, water quality, and conditions favorable to the continuing propagation of fish and wildlife, including endangered species. Chapter 343, HRS, "Environmental Quality Commission and Environmental Impact Statements", provides that environmental concerns be appropriately considered in water project implementation. While the statute engenders environmental sensitivity and fosters an appropriate balancing of economic and environmental values, it does not establish any legal rights in the public for the use of water in natural stream courses.

Chapter 37A of the Public Health Regulation, Hawaii Department of Health, provides for the identification of the waters of the state and establishes water quality standards for coastal water and fresh water. Its classification of fresh water uses to be protected include drinking water supply, food processing, the support and propagation of aquatic life, compatible recreation, and agricultural and industrial water supply. The regulation provides principally for the preservation of aesthetic values and the propagation of fish and, to a lesser extent, the protection of human health.

Problems encountered include difficulty in regulating pollutant discharges, classified in accordance with nutrient levels and other criteria based on mainland data and monitored water quality in streams and lakes. In an effort to meet the fishable/swimmable criteria of the Federal Clean Water Act, and the State Environmental Quality and Coastal Zone Management Acts, the Department of Health proposed amendments to its Water Quality Standards in May 1978 to protect instream flows. However, it was agreed that the Department of Land and Natural Resources was a more appropriate agency to take the lead, and the proposal was therefore dropped.

The usual assessment of current water use and projections of future demands account for traditional offstream uses--municipal, agricultural, industrial, and military--but do not include water for instream ecological, aesthetic, and recreation purposes. There is an apparent need to identify, correlate, and tabulate instream values, stream by stream, in addition to stream characteristics. A waterfall or scenic stretch of stream, for example, has an aesthetic value particularly vulnerable to water management practices. The instream values identified in the Hawaii Water Resources Plan (January 1979) can be used as a base of reference for increased emphasis on environmental resources.

Recommended Objectives

The following objective will help achieve the environmental goals of the Hawaii State Plan.

Objective L: ESTABLISH A PROGRAM FOR INSTREAM FLOW MANAGEMENT AND DEVELOP INSTREAM FLOW STANDARDS.

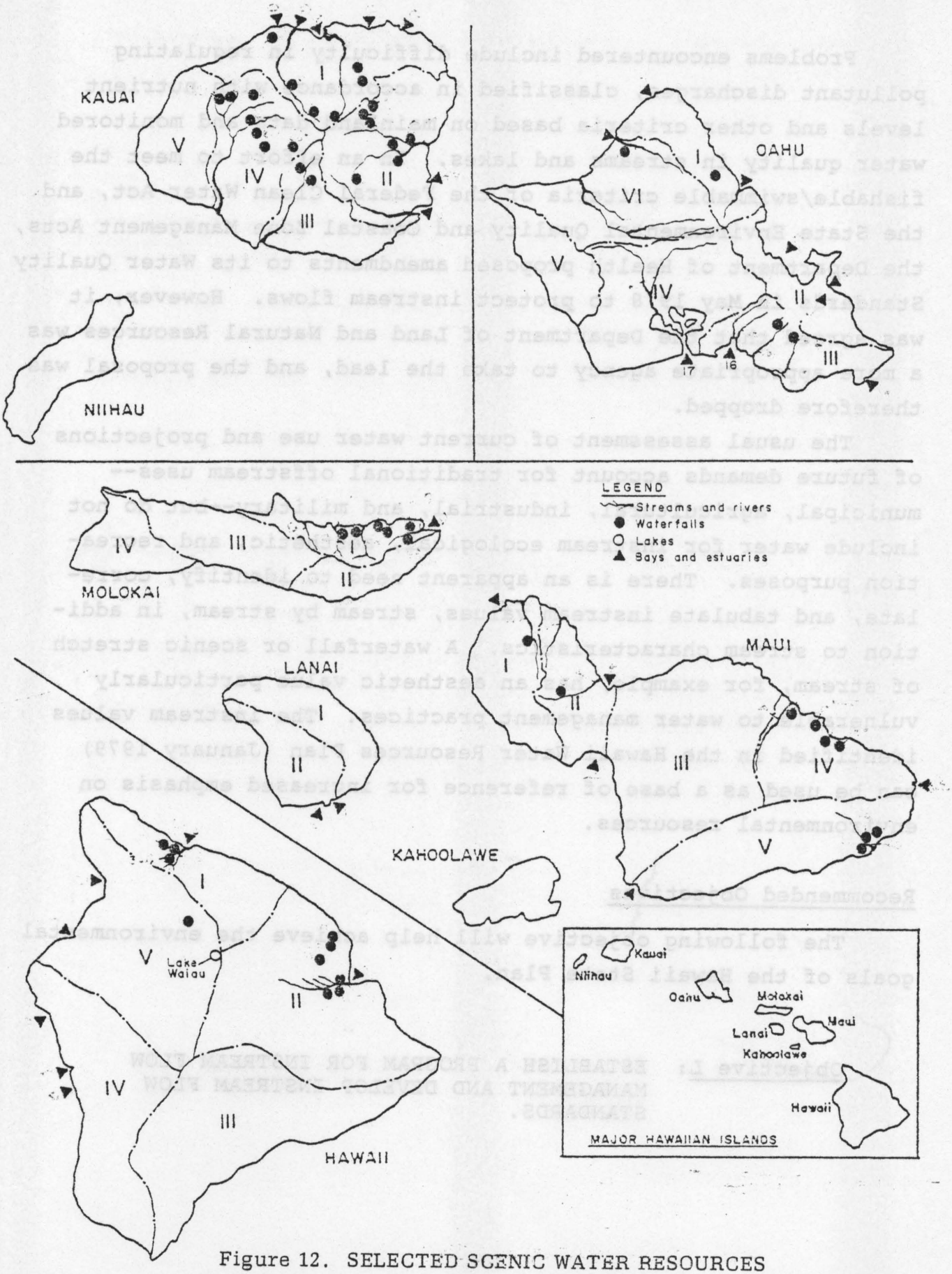


Figure 12. SELECTED SCENIC WATER RESOURCES

Source: Hawaii Water Resources Plan, January 1979.

Basis. A fundamental problem is the inadequacy of data to allocate stream water for beneficial instream and off-stream uses. In order to develop instream flow standards, data must be collected, stored, and tabulated for easy retrieval. Such data are needed to quantify instream values, to document the need for their protection, and to identify conflicts and tradeoffs among alternative uses. Lack of a definitive base of information results in haphazard protection of instream uses.

The accumulated data will be used as a basis for management decisions to protect existing instream values and to support legislation for instream flow standards.

5. WATER FOR AQUACULTURE

Situation

Hawaii is an excellent location for aquaculture. The state has warm temperatures the year around, sufficient unused or underutilized land well suited for fresh, brackish, and salt water aquaculture, and a tradition of fish farming that extends back to the ancient Hawaiians. However, economic development over the past 100 years has concentrated on agricultural resources. Only within the last decade has a concerted effort been made to identify aquatic resources and opportunities, and to estimate the potential economic benefits of a thriving aquaculture industry.

Development of the aquaculture industry has been assisted by such State agencies as the Department of Planning and Economic Development, Department of Agriculture, College of Tropical Agriculture, and Department of Health.

Preliminary assessments have been favorable, and scientific research on a number of aquatic species has produced encouraging results. However, the most compelling reason for

optimism is the early success of fresh water prawn farming which, in a few short years, has established Hawaii as the world leader in the culture of this species.

The industry is expanding rapidly. Wholesale value for aquaculture production reached $265,000 in 1977, an increase of 34 percent over 1976. Aquaculture products were grown on 20 farms utilizing 248 acres; the 1977 wholesale value represented a gross return of $1,070 per acre.*

In order for aquaculture to realize its full potential, the Governor has recommended to the Legislature that the Department of Land and Natural Resources be designated the state lead agency to coordinate research, development support, and promotion of the industry.

Opportunities. As the only state with climatic conditions favoring the growth of tropical and temperate-zone aquatic species the year around, Hawaii has an opportunity to achieve leadership not only in commercial aquaculture production but also in aquaculture research, training, and technology transfer activities as well.

It is projected that 2,429 acres will be farmed by 313 direct employees by 1985, producing 16.8 million pounds of aquaculture products worth $32.6 million. This level of production would represent a gross return of $13,440 per acre and $104,150 per direct employee.

These projections are based upon the potential market both in Hawaii and on the Mainland. Approximately 30 million pounds of seafood are consumed annually in Hawaii, of which imports comprise 55 percent. Total consumption of seafood on the Mainland amounted to 2.7 billion pounds in 1976, of which 60 percent were imported from foreign sources.

*"Aquaculture Development for Hawaii", State Department of Planning and Economic Development, 1978.

Expansion of aquaculture can help to achieve the economic, social, and environmental goals of the State by providing employment opportunities, contributing to the balance of trade by increasing exports and displacing imports, diversifying the economy, leading to self-reliance in food production, maintaining open spaces, reducing development pressure on prime agricultural lands, and preserving the life-styles of rural residents and the quality of life of all citizens.

Development Constraints. The slow rate of aquaculture development in Hawaii has been due somewhat to major constraints, which fall into three categories: (1) technical, including biological and production problems, (2) financial, and (3) legal-institutional.

A serious technical problem has been the lack of large-scale growout experimentation facilities approximating actual commercial conditions. The performance of fresh, brackish, and salt water species cannot be adequately evaluated without testing in such a facility. Biological limitations have resulted from the selection of species appropriate for research but not necessarily the most important for commercial production,

An additional technical problem has been the lack of means to transfer technology to Hawaii. Aquaculture researchers have had to observe and study technology developed elsewhere and apply the results to Hawaii's conditions.

The lack of experimental facilities not only to test and evaluate species, but also to demonstrate commercial feasibility has impaired the availability of credit. Another obstacle to credit availability has been the failure of aquaculture to qualify for assistance from the U. S. Department of Agriculture and the Small Business Administration. The establishment of the Aquaculture Loan Fund in the Hawaii State Department of Agriculture in 1972 helped to overcome this obstacle.

Since the volume of aquatic products in Hawaii has been relatively small, no significant marketing problems have yet emerged.

The many and varied public regulations and permit requirements for starting an aquaculture venture in Hawaii demand a considerable investment in time and money before operations can begin. A simplified, coordinated permit procedure that would expedite agency processing of permit applications would facilitate expansion of the industry.

Another impediment to aquaculture production in Hawaii is the complex of legal problems raised by state and federal regulations in such matters as state vs. private water rights, stream flow diversion, water transfer, ground and surface water use, and historic agricultural uses of water.

Assessment of Resources. An assessment of Hawaii's land and water resources suitable for aquaculture reveals the following:

(1) There are more than 135,000 acres of primary lands and nearly 500,000 acres of secondary lands suitable for aquaculture.*

(2) There is and will continue to be, competition for fresh water in certain locations on Oahu, Maui, and the Big Island. However, there is sufficient fresh water for the immediate expansion of aquaculture production in many other areas of all Islands. There is also a long-term potential for utilizing agricultural water supplies that may become surplus to future agricultural needs.

---

* Primary lands suitable for aquaculture meet all of the following criteria: (1) below 3,000 feet elevation, (2) clay, clay-loam, or loam soil type, (3) slope of not more than five percent, and (4) outside of Urban Districts. Secondary aquaculture lands have the same characteristics but include all soil types other than clay, clay-loam, or loam.

(3) There is an abundance of warm, unpolluted seawater, but there are limitations to open-ocean and near-shore marculture.

Recommended Objectives

Aquaculture in Hawaii would be enhanced through the adoption of the following objective:

Objective M: DEVELOP WATER SUPPLIES FOR AQUACULTURE.

Basis. Inland fresh water aquaculture is considerably more advanced and has a greater economic potential than mariculture. Therefore, a program should be developed to provide water to those inland areas in the state considered physically suitable for aquaculture.

6. WATER RESOURCES MANAGEMENT

Situation

Water resources management, planning, and development have become increasingly important government functions as water demand has increased and problems in meeting the demand have emerged. In order to deal with these water problems effectively, there should be a clear definition of the role of the state government. This requires consideration of state functions from an overall perspective that includes related functions of federal and county governments.

Until quite recently, State governmental activity in the field of water was primarily aimed at promoting the economic development of the islands, and large sums of state monies were spent in upgrading and developing new domestic water systems, particularly on the neighbor islands where the demand for improvements was greater and the fiscal

capacity of the county government to fund the improvements was generally lower. Over the past years, however, other uses for the water supply have emerged. Increasing recognition is being given to satisfying demands for water which could provide improvement in the quality of living; consequently, the value of water in uses such as recreation, aesthetics, and maintenance of fish and wildlife in streams has increased relative to the traditional uses for drinking, industry, and agriculture. The combination of this expanding array of options for water use, and the changes over time in the relative social values placed on these options, has led to changed perceptions of what consitutes desirable development patterns. The important decision today is not whether to develop water; but, rather, which of the competing uses will be allowed to develop. The basic question is how far the State should interject itself into decisions on where, by whom, and for what, the waters of the State will be used.

In order to understand the responsibilities of the State in water management, it is necessary to review the Federal-State-County relationship in programs for water planning, water development, water conservation, and water use regulation. Such a review will show instances of program fragmentation and overlap, and even absences of needed programs. The presence of "gray areas" in governmental responsibilities may be understandable because Federal, State, and County water resource objectives often are not necessarily the same, or even parallel. Federal water programs touching Hawaii are heavily oriented toward flood control, watershed protection, navigation, and water quality control. Recent changes in Federal law call for direct State and County participation in programs for pollution control (PL 92-500), drinking water quality (PL 93-523), inland water recreation development

(PL 88-578), water resources planning (PL 89-80), and fish and wildlife maintenance (PL 85-604).

Counties traditionally have assumed responsibilities for municipal water supplies, wastewater treatment, drainage, and flood control, to the extent State statutes permit them. For example, the statutes provide for the creation of county boards of water supply to "manage, control, and operate the waterworks of the county and all property thereof for the purpose of supplying water to the public in the county."

Some general observations can be made in assessing the concepts of State responsibility for water resources planning, management, and development. In a very broad sense, the State role is heavily management oriented, whereas the county role, and to a lesser extent the Federal role, is proportionately more development oriented. In pursuing its management role, the State is more concerned with (1) how water would be allocated among the various competing uses; (2) the protection of water rights; (3) controls over withdrawals of both ground and surface water; (4) the management of water quality; (5) the availability of water to encourage municipal, industrial, and agricultural growth; (6) the protection and enhancement of environmental values; and, importantly; (7) the provision of the neceesary monies to address these concerns. To be successful in managing its water resources, the State needs to develop strong programs in basic data collection, planning, policy development, implementing legislation, and public education.

The trend has been towards making one state agency administratively accountable for developing a comprehensive water management program. The necessity for considering all needs in water resources planning--water supply, irrigation, water quality management, instream uses, hydropower, flood control, recreation, and aesthetics--will hasten this trend. The recently amended Hawaii State Constitution embraces this single-agency concept. However, it is doubtful, as evidenced by the experiences

of other states, whether all water activities can be put into a single agency. Presently, for example, municipal water supply falls within the purview of the county governments; water quality management is handled by the State Department of Health; water use regulation is shared to a limited extent by the State and the Honolulu Board of Water Supply; and flood control is prominent at the Federal and County levels.

While State objectives for water resources management are enunciated in the Hawaii State Plan and are more specifically addressed in this State Water Resources Development Plan, clear-cut statewide water resources policy has yet to be legislated, along with a desirable administrative framework to implement such state policy. The Water Resources Development Plan recognizes the complexity of the water management issue and the need for a careful study of the role of the State government in managing its water resource. It accordingly recommends that a State water code be legislated. This State water code would, as detailed in the following section, be a statement of State policies, principles, and rights on the subject of water management and administration. A significant component of the water code would be the administrative framework devised to execute the functions assigned in the code. Here, the framework would clearly define Federal-State-County relationships in water resource management and specify agency functions and responsibilities for water programs and activities.

Another water management issue that needs to be addressed is that relating to water rights. The current system of water rights laws in this state, based upon ancient Hawaiian customs and evolved over the years through case law, is not clear and is difficult to administer. Conflicts over water use usually must be resolved, case by case, in legal proceedings.

As the basis for settling disputes, the system has limitations: It is limited to those situations brought before the courts. It generally places the burden of proof on injured

parties, with the result that a water user may do as he pleases until someone sues to stop him. It leaves the determination of reasonable water use to the courts. It is time-consuming and costly.

These inadequacies in the present system of water policy and law justify the exploration of alternative bases for water management decisions. The concept proposed is that of a declaration of the state's jurisdiction to regulate all water resources in Hawaii and the creation of the necessary administrative framework to carry out the control function.

A state water code would serve to specify statutory language on water rights and to review agency responsibilities in water management. All affected sectors of the community will get together in formulating on a joint basis a clear and concise water code for the legislature to adopt.

The state's scope of interest and authority extends to basic data collection, water planning, administration and enforcement of water use control and water quality laws, watershed management, flood abatement, and protection of instream values.

Recommended Objectives

Functional plan objectives for water resource management, stemming from and consistent with the broader goals and objectives of the Hawaii State Plan, are recommended as follows:

Objective N: ENUNCIATE BASIC STATE WATER RESOURCES POLICY AND IMPROVE ADMINISTRATIVE FRAMEWORK.

Basis. Some of the major shortcomings in present water resources management--the lack of explicit policies on water rights, overlapping administrative functions, and fragmented legislation--can be greatly minimized by the

adoption of a state water code. By expressly conferring necessary powers over water resources to the state, while preserving or granting private rights to beneficial use, and by improving the administrative framework, a water code would enable the state to manage water resources more comprehensively and efficiently.

The water code would determine who shall have the ultimate authority to control the use of water, what powers should be conferred on the administration, and how traditional Hawaiian water law might be accommodated.

Provisions of a state water code should include the following:

(a) Rights in natural waters. These provisions would establish the respective rights, powers, and duties of government and private users over water naturally occurring in its various forms. It would define those sources and other matters subject to administrative control and those sources that may be freely used without administrative intervention.

(b) Necessary powers relating to land. Certain ancillary powers to undertake or control actions on land are essential to effective water management. Thus, measures may be necessary to protect the beds and banks of streams, to prevent erosion or pollution, or to take emergency actions on land.

(c) Registration and licensing of water use. As demand increases, it becomes important to adopt some means of determining who shall have the right to use water and how much he shall be entitled to use. It is therefore necessary to allow for registration, protection, and measurement of various water uses.

(d) Administrative structure. It is necessary to designate or establish those administrative agencies responsible for developing and controlling water; to define their purpose and objectives; to confer necessary powers upon them; and to provide for their organization and funding.

Other matters might also be included in a water code for Hawaii. However, the above are regarded as most essential.

Objective O: PROVIDE FOR WATER USE CONTROL.

Basis. Although Hawaii is endowed with plentiful water resources in the aggregate, increasing water needs will eventually approach sustainable yields in particular areas of heavy demand. It is thus desirable that the state direct attention to the regulation of water withdrawals before a crisis arises. As competition for the sustainable yield of water sources intensifies, judicial decisions may not be adequate to meet social needs. In the light of this situation, the recent 1978 Hawaii Constitutional Convention deliberated a proposal calling for better management of the State's water resources, particularly in the area of water use regulation. This proposal, subsequently adopted and now comprising Section 7 of Article XI of the Constitution, reads in final form as follows:

"WATER RESOURCES

"The State has an obligation to protect, control and regulate the use of Hawaii's water resources for the benefit of its people.

"The legislature shall provide for a water resources agency which shall set, as provided by law, overall water conservation, quality and use policies; define beneficial and reasonable uses; protect ground and surface water resources, watersheds and natural stream environments; establish criteria for water use priorities while assuring appurtenant rights and existing correlative and riparian uses; and establish procedures for regulating all uses of Hawaii's water resources."

This Constitutional provision can be implemented under existing statutes and the present framework of administrative agencies, with the enactment of amendatory legislation by administrative action as the need arises. Here, the existing Ground Water Use Act (HRS Chapter 177) is contemplated to serve as the basic vehicle through which all development and use of water in the state would be controlled by a state agency; namely, the Department of Land and Natural Resources that now administers the Act.

So as to achieve comprehensiveness in coverage and control, the Ground Water Use Act would be expanded to encompass all ground water areas, whether designated as threatened by the Board of Land and Natural Resources or not, as now required, and to include surface waters as well. This arrangement, whereby the existing administrative structure is maintained and the present statute is utilized and broadened as needed, provides the water resource management and control sought by the above constitutional amendment.

Also, in concert with the data collection and aquifer assessment effort under the Ground Water Use Act and to facilitate the eventual statewide administrative of all surface water uses, both offstream and instream, the State would embark on a program to inventory and register all such uses. Formal registration of existing source utilization would complement a more comprehensive future program to control the use of water sources throughout the state.

Objective P: MINIMIZE STORM WATER DAMAGE.

Basis. Annual flood damage in Hawaii has been roughly estimated to average $1,850,000. There is also a toll in human life, even though a high degree of flood protection has been provided, at great cost, for most communities.

Millions of dollars have been invested in flood control works and related measures by the Federal government. The principal programs through which the Federal Government attempts to reduce the drain on the economy and the human suffering that result from flood are, in brief:

(a) The flood control activities in urban areas by the Corps of Engineers of the United States Army.

(b) The watershed and land treatment programs of the Soil Conservation Service of the U. S. Department of Agriculture.

(c) The flood insurance program directed by the Federal Insurance Administration of the U. S. Department of Housing and Urban Development.

There are a number of measures that can be used to mitigate flood damages. Flood plain areas where people and property are already concentrated may be given full or partial protection by construction of engineering works such as reservoirs, levees, channel improvements, and bypasses.

When it became apparent that new flood problems were being created faster than the old ones were being eliminated, other measures began to receive serious attention. These included the regulation of flood plain uses to prevent development that would be subjected to excessive damage during floods and to require that any structures built on flood plains be designed to withstand flooding effects. The latter measure, sometimes called "flood-proofing," finds favor where land suitable for development is limited.

Flood losses can also be reduced by warning occupants of the threatened area and helping them to evacuate. The use of this technique is dependent upon flood forecasting. The federal government provides flood warnings through its National Weather Service. Reliability in predicting flood stages on

the major streams is rather high, and warning times are sufficiently long to permit removal of endangered property. However, flash floods from small drainage areas, particularly in mountainous areas, cannot always be predicted far enough in advance to make it possible to protect movable property. Flash flood warnings can, at best, save lives if they are heeded.

Federal, state, local, and private organizations cooperate in carrying out emergency flood programs. Overall coordination is provided by the U. S. Office of Emergency Preparedness, and tax relief and disaster relief loans and grants are provided in severe cases.

A comprehensive plan for mitigating flood losses should arrive at the best combination of the foregoing measures.

There is a need for a better understanding by the public at large of the basic nature of the flood problem, in particular, that the ultimate goal of all public flood control programs is the best use of flood plains.

All counties in the state are receptive to the National Flood Insurance Program, created by Congress in 1968 in response to the need to provide flood damage insurance at subsidized rates. They are currently developing, and nearing adoption of, the land-use regulations needed to implement the program in their areas. Under this program, communities would carry out flood plain management measures to protect lives, homes, and businesses from future flooding.

In addition, Congress enacted Public Law 92-367 for a national dam inspection program to protect life and property. The Corps of Engineers is responsible for the inspection program in Hawaii. The Governor is notified of investigation results and potentially hazardous conditions. Owners of dams considered hazardous are informed of measures that should be taken to minimize the threat to life and property.

At present, there are no Hawaii statutes relating to dam safety. Appropriate legislation to regulate the design, construction, maintenance, and operation of dams and reservoirs is needed to implement an effective dam safety program.

Objective Q: PREVENT CONTAMINATION OF SOURCES OF WATER SUPPLY.

Basis. The development of the Islands has contributed to the deterioration of water quality. Streams and coastal waters have been polluted by the discharge of wastes, by runoff from developed areas, and by erosion and sedimentation. Ground water is being subjected to salt water intrusion because of overdraft and to pollution from subsurface waste disposal, largely from cesspools.

Primary responsibility for water quality management in the state is vested in the Department of Health. The department identifies both ground and surface water quality problems in the state and controls pollution abatement and prevention. It has promulgated water quality standards and monitors water quality statewide.

The Department of Health is the state agency designated to coordinate the implementation of federal water quality laws: The Federal Water Pollution Control Act Amendments of 1972, the Safe Drinking Water Act of 1974, and the Toxic Substance Control Act of 1976. The requirements of these laws are reflected in the department's regulatory programs to monitor, report, and control water quality at the consumer level. Water quality and pollution control from a statewide perspective is discussed in detail in the State Health Functional Plan.

Prevention of contamination of surface and ground water sources of domestic water supply is the major water quality

concern within the scope of this functional plan. Increasing accumulations of pollutants in addition to posing a health hazard, impair water source utility and place operational and financial burdens on municipal water systems. Emphasis should be placed upon preventive rather than corrective measures.

As discussed previously, the Safe Drinking Water Act of 1974 brings domestic water systems under state surveillance and requires suppliers to conduct extensive water sampling and monitoring programs. Of great concern to domestic water suppliers--both county municipal water systems and private systems--is the high cost of monitoring water supply quality and laboratory testing, not to mention the capital outlays for treatment plants that may be required. There is also concern that small systems may not be able to afford the technology to bring water quality up to standard.

A less noticeable, yet pervasive, water quality problem in Hawaii is contamination of ground water sources by cesspools and salt water intrusion. Cesspool seepage is a potential problem mainly on the Neighbor Islands where there are few sewerage systems. Present regulations curb the intensifying of this threat by limiting the use of cesspools to sparsely populated areas where there is no danger of contaminating the ground water supply.

The degradation of ground water aquifers by overdraft is a problem on all islands to some extent. Withdrawals from the basal lens of fresh water underlying the islands, if not properly managed, can result in contamination by the intrusion of salt water. When fresh water is withdrawn from the basal aquifer faster than the rate of recharge, the underlying salt water will move upward into the fresh water lens to displace the overdraft. Excessive pumping from a large well can produce upward currents in the fresh water lens, resulting in an

increase of salinity in the particular well and a persistent thickening of the brackish transition zone interfacing the fresh water lens and the underlying salt water. Salt water intrusion of basal aquifers can best be minimized or avoided by improved well spacing and pumping schedules, based upon an expanded observation well program and applied research. Also, caution needs to be exercised to prevent salinity and other water quality problems that might result from infiltration of excess irrigation water of poor quality.

Another problem--one that continues to be the main contributor to water degradation in the State--is that of pollution from non-point sources; that is, diffused wastes reaching water through land runoff. Excesses of sediments, chemical fertilizers, and pesticides transported by water can increase the expense of water treatment for municipal and industrial purposes, increase the costs for water control projects, impair recreation, interfere with aquatic species, and in some extremes pose a threat to human life. For the problems and conflicts among water uses that such non-point pollution can lead to, it is important to provide for some measure of administration by government agencies through their pollution control programs. Here, the programs of the State Soil and Water Conservation Districts (SWCD), designed to help farmers to adopt soil and water conserving practices and recently broadened by federal law to allow participation in pollution control meausures, play an important role in mitigating damages from soil erosion, sedimentation, and stream pollution. Recognizing that water-caused pollution is preventable by the exercise of control over contributing activities, such as earthmoving in connection with construction projects, the State has designated the SWCD as the management agency to implement the erosion and sediment control component of the State's "208" planning program. The SWCD would, in essence, work in concert with the counties in enforcing the latter's legislatively mandated ordinances to control land erosion.

Objective R: ENHANCE MANAGEMENT OF WATERSHEDS.

Basis. Water has long been recognized as the most important resource of Hawaii's forest lands. These lands extract from the the moist trade winds that pass over them much more rainfall than would otherwise fall. They are the sole source of water for low lying urban and agricultural areas. (See Figure 13).

The efficiency with which rainfall in watersheds contributes to streamflow and ground water recharge vitally affects water resources available for beneficial use. Watershed management determines to a large extent the quantity and quality of water supplies that can be developed, and the amount lost as surface runoff and flood flows.

Today, state-owned forest reserves and much of the privately owned forest land within Conservation Districts are generally in good hydrologic condition. A 70-year policy of watershed protection has resulted in substantial improvement from acute watershed conditions at the turn of the century. Probably nowhere else in the United States has a more intensive and successful program of watershed protection been developed. Increased development of lowland areas and demand for water will require continued protection and management of the reserves to sustain and increase water yields of suitable quality as well as to minimize floods and sedimentation.

Despite improved conditions within forest reserves, the protection of forest cover in watersheds is of major concern in Hawaii today. Developments that accelerate the demand for water also have an impact on the watersheds--the source of needed water supplies. Many forests with important watershed values are not in Conservation Districts. Conversion of these lands to more intensive uses--for example, urbanization, cultivated crops, and pasture--is continuing at a rapid rate. Recent hydrologic studies have shown that conversion of forest land to other uses and intensive grazing of forest lands contribute to flood runoff and erosion and lessen percolation to

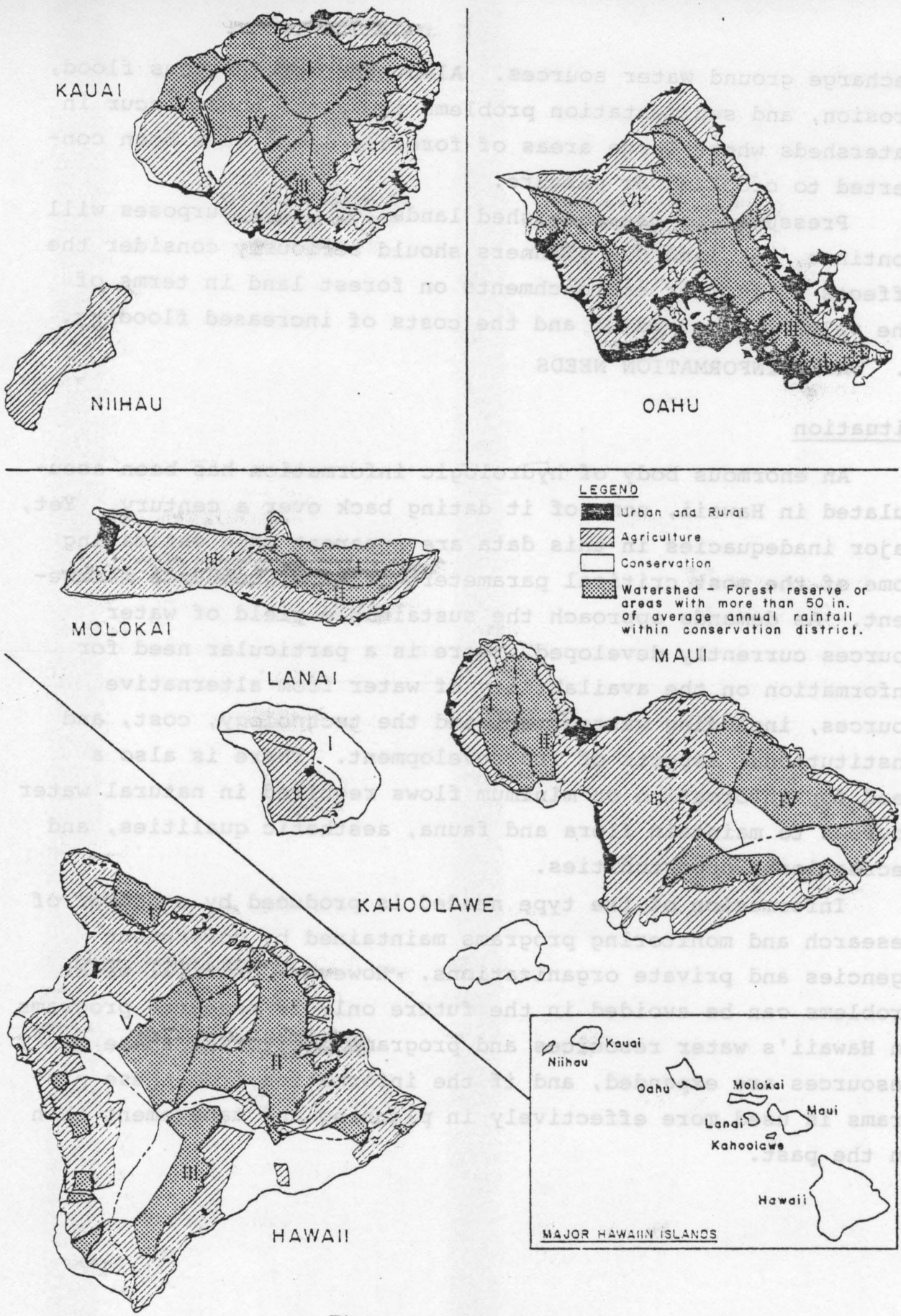


Figure 13. WATERSHEDS

recharge ground water sources. Also, the more serious flood, erosion, and sedimentation problems in Hawaii today occur in watersheds where large areas of forested lands have been converted to cropland or pasture.

Pressures to use watershed lands for other purposes will continue, but land use planners should seriously consider the effects of further encroachments on forest land in terms of the value of lost water and the costs of increased flooding.

7. WATER INFORMATION NEEDS

Situation

An enormous body of hydrologic information has been accumulated in Hawaii, some of it dating back over a century. Yet, major inadequacies in this data are apparent when estimating some of the most critical parameters in water resource management. As demands approach the sustainable yield of water sources currently developed, there is a particular need for information on the availability of water from alternative sources, including wastewater, and the technology, cost, and institutional aspects of its development. There is also a need for information on minimum flows required in natural water courses to maintain flora and fauna, aesthetic qualities, and recreational opportunities.

Information of the type needed is produced by a number of research and monitoring programs maintained by government agencies and private organizations. However, critical water problems can be avoided in the future only if research programs on Hawaii's water resources and programs monitoring these resources are expanded, and if the information from these programs is used more effectively in planning and management than in the past.

Recommended Objectives

The following research and data collection objectives are recommended in pursuit of the broader objectives and policies of the Hawaii State Plan.

Objective S: EXPAND RESEARCH PROGRAMS

Basis. Research is an integral component of water resources management. Its purpose is to better understand, use, and manage these resources. As demands increase, research is needed to improve methods for supplying water at reasonable costs and for disposing of wastewater in ways that are environmentally and economically acceptable. Rapidly changing social concerns and environmental problems require that research programs be relevant and responsive to real problems and issues.

The organization of research activities in water resources and related fields is varied and complex. While federal funding is predominant, actual research is carried out by a variety of government agencies, universities, industries, and independent organizations. State water resources research and development are generally confined to Hawaii-oriented problems and is often cooperatively funded by federal agencies. The University of Hawaii conducts basic and applied water research on a broad spectrum, from a single-interest viewpoint to an interdisciplinary approach.

The major contribution to research progress by private industry has been directed toward solving industry problems, such as the development of equipment to improve water use efficiency and to cope with waste products. For example, the sugar industry conducts research in recycling industrial wastewater, drip irrigation, and reuse of sewage effluent in cooperation with government agencies.

The identification of research needs is a continuing process and no two priority lists are alike; ranking varies according to viewpoints. Those areas where major research is most needed include:

1. Ecological, environmental, and socioeconomic impacts of water resources development and management.

2. The economic, social, and environmental costs and benefits of (a) various levels of wastewater treatment, including the no discharge alternative, and (b) changes in water-using processes to achieve required levels of water quality.

3. Relationships between energy production and water use and the effects of heat and consumptive use on local water resources.

4. Effects on water quality of non-point sources of pollution, including investigations of alternative means of control and study of urban storm water control in relation to the quality of Hawaii's water bodies.

5. Means of more efficient water use and extending the utility of existing supplies.

6. New and developing water technologies, including desalting, weather modification, wastewater reuse, and geothermal resources.

The first three areas of research are particularly important in the light of current emphasis on environmental quality.

The funding of water-related research projects is in many respects a responsibility of everyone involved in water resources. Particularly, agencies that will benefit from the research and monitoring programs should contribute to their support.

Objective T: IMPROVE DATA COLLECTION, ANALYSIS AND DISSEMINATION PROGRAM.

Basis. Basic data on water and related matters provide a basis for evaluation, planning, and decision making. A good

basic data program includes data collection, storage, retrieval, dissemination, and means for anticipating probable future needs.

Although quantitative data on surface water have been adequate in general, there are some deficiencies. For example, coverage of ground water, even at the level of "general inventory," is incomplete. Water quality data have fallen behind the pace of interest and demand. Climatological and hydrological programs, while generally adequate, have been inadequately coordinated. Recent developments promise a much improved coordination system with respect to water quantity and quality data, however.

While water data collection in the past has concentrated on determining water quantity, future concerns will require more information on water quality and on the interrelationships between water and other aspects of the environment. There are increased needs for data for impact analyses, to measure program effectiveness, and upon which to direct policy on such matters as flood damage reduction, water quality controls, and water use.

Owing in part to the pervasive nature of water resources and the wide range of interest involved, many people presently do not know what services are available and where, in what forms they are available, and how to get needed data. This situation could be corrected by establishing a referral center as to sources of water and water-related data. The center would maintain a continually updated reference system for water and water-related data, indicating what kinds of data are available, in what forms, and where the data are available. Water agencies should cooperate more extensively with general data collection and statistical agencies such as the State Department of Planning and Economic Development to encourage collection of data useful for water resources planning and management.

A continuing problem is to insure that data collection and dissemination are relevant to present and probable future needs of users and decision makers. Opportunities exist to mount such an effort within existing programs.

Influences which must be dealt with in the future include the following:

1. A greater number of people will be concerned with water, water data, and water predictions. Water data will no longer be of concern only to specialists.

2. There will be increased demand for hydrological and environmental integration; water quantity will have to be closely related to water quality. The interrelations among precipitation, ground water, and streamflow, coupled with water quality, could be the first step in this integration process.

3. Data collection will have to be expanded to include environmental information, such as the ecological and aesthetic aspects of surface water landscapes and the identification of aquatic ecosystems.

4. The need will increase for information on underground storage capacity and on relationships between surface water and ground water systems.

5. Demand for information on water costs, water use, and waste discharge will increase.

6. There will be greater emphasis on active rather than passive data storage whereby routine statistical analysis can give prompt answers to queries.

7. Operations, management, and forecasting will require data which are recorded and reported practically simultaneously with the occurrence of the event.

8. There will be greater use of remote sensing (aircraft and space satellites) for data collection and transmission.

9. Data systems will need to be designed to permit (1) feedback from monitoring, (2) analysis of requests for data at data centers, and (3) analysis of the effects of planned actions on water and the environment.

10. The demand for and importance of social and economic data related to water use will increase at a very rapid rate.

11. Multiobjective planning for water resources and plan implementation will require a much broader data base than in the past.

12. There will be an increasing need to develop social and environmental indicators (i.e., aggregate measures of data) to better judge program performance and to develop environmental baselines.

13. There will need to be an adequate and comprehensive program for collecting flood damage data to provide the basis for planning flood control works to more effectively reduce flood losses.

The adequacy of the water resources data program in meeting past needs is relevant only to the extent that it provides a guide for developing a program to meet future needs.

8. FINANCING WATER PROGRAMS AND PROJECTS

Situation

A major involvement of the State in water resources development is represented by the heavy infusion of State grants-in-aid, loans, and technical assistance to the counties, particularly the neighbor-island counties, for water programs and projects. Financial support for municipal water projects continues to be extended, premised on the policy that benefits should be provided statewide as a public good for the economic and social values generated, consistent with overall state goals.

A basic concern connected with this State involvement in financing water projects lies with the project selection process. Disbursements for municipal water system improvements, for example, have been guided over the years by the following broad considerations: (1) that because municipal waterworks management is a distinct county function, the State's role in financial participation would essentially be one of assistance; (2) that because the fiscal capacity of the counties vary, the element of need would be an important factor in the extent of assistance rendered; and (3) that State assistance funding would be confiened to projects involving major source development, transmission, and storage works. Despite questions of consistency and equity, this approach has worked reasonably well, largely because the State and County water agencies have worked closely together and have cooperatively developed their capital improvements programs.

Recommended Objectives

The following set of objectives are intended to expand upon the broader objectives and policies of the Hawaii State Plan relative to fiscal management.

Objective U: IMPROVE STATE GRANT AND LOAN PROCEDURES FOR WATER PROGRAMS AND PROJECTS.

Basis. Spending for government services is a growing public concern at the state level and particularly so at the county level, where the revenue base is smaller. As a result, public financing of water programs and projects is becoming increasingly difficult. Alternative sources of funds need to be explored as counties undertake water projects of expanded scope and as the state aggressively encourages diversified agriculture and aquaculture programs requiring the development of many separate water systems.

In view of the fact that financing is the heart of policy implementation, the State needs to review its overall water funding program, reassess its own financial capacity, and set realistic program goals.

Financial Planning. Requests for water project funds are usually presented to the Legislature in the following ways: (1) through the Administration's executive budget system, (2) through CIP requests of state departments, (3) through CIP requests of county water departments, and (4) through the initiative of the legislators.

Because of the absence of clear legislative policy on the subject, outlays for water programs and projects have not always been systematic. It is desirable that in the selction of water resource projects for State financial investment, there should be developed uniform objective evaluations. On the bais of these evaluations, there should be established by the water agencies an array of projects recommended for funding on the basis of their urgency, economic feasibility, and consistency with the objectives of the Hawaii State Plan. Finally, from this array there should be established a capital budget which would be recommended to the Legislature for funding. This Functional Plan on Water Resources Development should be the basis and the vehicle for the orderly authorization and financing of such water programs and projects.

Objective V: EXPLORE ADDITIONAL WATER FINANCING PROGRAMS.

Basis. Investments in major water facilities can continue to be expanded and financed through the issuance of bonds and through grants-in-aid from upper levels of government, but such traditional sources of funds have inherent limitations. Alternative methods of financing governmental expenditures for future water resource developments should be explored. Presently, State water resources development funds are spent directly for

state programs and projects and indirectly in support of county programs and projects. Such water programs are primarily ancillary to programs for housing, agriculture, recreation, and conservation. For example, domestic water systems are installed by the State in conjunction with urban land developments and irrigation works are built in conjunction with state agricultural parks.

In line with growing federal practice, the concept of cost-sharing, heretofore not applied to state financing of water projects, should be considered. Besides requiring project beneficiaries to bear their share of the costs, this procedure would provide an incentive for the selection of worthwhile projects and permit direct involvement by beneficiaries in water project decisions. Cost-sharing formulas need not be uniform, but could be varied to suit the particular purposes and programs. However, cost-sharing should not entirely supplant subsidies, which are justified when they serve some compelling social purpose, such as the provision of reasonably priced housing, or further some public policy, particularly those enunciated in the Hawaii State Plan.

As noted in an earlier section, financing municipal water projects is essentially an urban problem, and the various county boards of water supply, in pursuing their policy of allocating costs of water facilities and services to the beneficiaries, are depending on private capital to share the increased capital cost where appropriate. Land developers and new consumers seeking municipal water services are being asked to finance a greater portion of the cost of providing that service; in some counties, the developer of a land project is required to finance the entire cost. These "user charges", expected to play a significant part in financing future water development projects, have ancillary benefits: they would help conserve water supplies, discourage premature investment in facilities, and provide for a more equitable allocation of water costs.

Federal financial assistance to the state and counties, currently made under some 225 programs including the 1972 program on general revenue sharing, should be pursued. Difficulties arise in trying to coordinate and manage the review of the various applications, however. Some water-related grant programs require a state plan under which projects are reviewed for their relevance to other state plans and programs or to county plans and programs. This Functional Plan on Water Resources Development and the complementary county development plans required under the Hawaii State Planning Act can be used to identify desirable water programs and projects and facilitate the processing of federal financial assistance applications.

The use of State and County bonds to finance water supply facilities for private land developments need to be investigated. This type of financing affords an effective means of encouraging private investments in rapidly developing areas. Also, the Federal government could assist the counties in accelerating capital improvements by guaranteeing loans from the private market.

Also, conservation incentives, besides conserving limited supplies, forestalls expenditures for capital improvements. Here, it might be desirable to require the implementation of community water conservation programs as a condition of state grants and subsidies for municipal water projects.

Further, any cost reduction through improved means of water development, delivery, and use lessens the financial burden. Research along these lines should be promoted.

CHAPTER IV

Objectives, Policies, and Implementing Actions

IV. OBJECTIVES, POLICIES, AND IMPLEMENTING ACTIONS

This chapter presents the recommended objectives, policies, and implementing actions for water resources development, which expand upon the Hawaii State Plan and reflect the analyses and recommendations of the preceding chapter.

The emphasis in the proposed implementing actions is on those which will have Statewide impact or for which the State has primary responsibility; however, actions involving other levels of government are also included. Detailed planning and budgeting will be required at the implementing agency level for many of the specific actions before actual implementation can proceed. It is intended that the proposed actions be sufficiently specific to provide direction for this process within the respective agencies.

The time frame for implementing actions is stated in terms of existing budgetary and capital improvement programming periods (two and six year time periods) and in terms of a longer-range period (beyond the current six-year budget period).

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan*

MUNICIPAL WATER

Objective A. ASSURE ADEQUATE MUNICIPAL WATER SUPPLIES FOR PLANNED URBAN GROWTH. — 5(b)(3), 16(b)(1)

Policy 1. Promote the development of new water supplies in support of planned urban growth. — 5(b)(3)

Implementing Action (a). Implement, to the extent consistent with prevailing state fiscal policy, the municipal water projects and programs proposed by state and county water agencies concerned. (see Appendices A & B)

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Funding commensurate with projects selected
Priority Relative to Other Implementing Actions: High

Policy 2. Continue to provide state grants and loans to the counties for municipal water projects and programs and provide for more equitable apportionment of such state grants and loans.

Implementing Action (a). Review current arrangements for state and federal assistance to the counties for municipal water projects and programs; improve policies to guide future grants and loans.

Lead Organization: DPED
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: $10,000
Priority Relative to Other Implementing Actions: Medium

*Chapter 226, Hawaii Revised Statutes

	Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Objective B.	SUPPORT LONG-RANGE MUNICIPAL WATER SUPPLY PLANNING BY THE COUNTIES.	104(b)(2)
Policy 1.	Augment long-range county planning for municipal water supply development.	104(b)(2)
Implementing Action (a).	Require the preparation of municipal water supply plans by the counties as a condition of future state financial assistance for county water programs and projects.	
	Lead Organization: County Water Agencies Assisting Organization: DLNR Time Frame: Ongoing Budget Estimate: May Require Additional Funds Priority Relative to Other Implementing Actions: Medium	
Implementing Action (b).	Consider appropriation of state funds for county water planning consistent with this State Functional Plan on Water Resources Development.	
	Lead Organization: Legislature Assisting Organization: DPED Time Frame: FY 1981-87 Budget Estimate: $40,000/FY Priority Relative to Other Implementing Actions: Medium	
Objective C.	PROMOTE MUNICIPAL WATER CONSERVATION.	16(b)(6)
Policy 1.	Encourage the wise use and conservation of municipal water supplies through public education.	103(h)(1)
Implementing Action (a).	Undertake a continuing public education program that stresses the full scope of water supply problems and the need to reduce per capita consumption.	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Policy 2. Promote water conservation practices to the extent practicable. — 16(b)(6), 103(h)(1)

Implementing Action (a). Establish a regular leakage control program for all municipal water systems.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: $40,000/FY
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Investigate restructuring of water rates to achieve water conservation.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: County Funded
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (c). Encourage the use of water-saving plumbing fixtures, and consider statutory or building code requirements for water-saving fixtures in new and renovated buildings.

Lead Organization: County Water Agencies
Assisting Organization: County Public Works Agencies
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

	Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Objective D.	IMPROVE DRINKING WATER QUALITY.	16(b)(4)
Policy 1.	Ensure a satisfactory level of drinking water quality throughout the state.	16(b)(4) 13(b)(3)

Implementing Action (a). Promulgate state drinking water standards no less stringent than those mandated under the Federal Safe Drinking Water Act, and provide for their adequate enforcement.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $20,000
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Adopt and implement a plan to provide safe drinking water under emergency conditions.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Enforce drinking water standards for all domestic water systems, public and private. 16(b)(4)

Implementing Action (a). Provide State financial assistance to counties for construction of treatment facilities needed to improve drinking water quality.

Lead Organization: Legislature
Assisting Organization: Dept. of Health
Time Frame: FY 1981-83
Budget Estimate: $4,500,000
Priority Relative to Other
Implementing Actions: High

Functional Plan Objectives, Policies, and Implementing Actions		Corresponding Provision of Hawaii State Plan
Objective E.	UPGRADE RURAL WATER SYSTEMS.	16(b)(5)
Policy 1.	Upgrade rural domestic water systems to provide adequate supplies of potable water.	16(b)(5)

Implementing Action (a). Seek federal assistance for the upgrading of rural water systems through such programs as the Consolidated Farmers Home Administration Act of 1961 and the Rural Development Act of 1972, and the services of the Economic Development Administration of the U.S. Department of Commerce.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: (Federal Funds)
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Consider consolidation of rural water systems to achieve economy of scale in upgrading facilities.

Lead Organization: County Water Agencies
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Additional Funds Required
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (c). Appropriate funds to upgrade rural water systems where necessary to improve the quality of life.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other
Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

WATER FOR AGRICULTURE

Objective F. IMPROVE THE QUALITY, EFFICIENCY, SERVICE, AND STORAGE CAPABILITIES OF SYSTEMS SUPPLYING AGRICULTURAL WATER. — 16(b)(4)

Policy 1. Preserve water for existing beneficial agricultural uses and provide additional irrigation water where needed by further development of existing surface and ground water sources and improvements to diversion, storage, and transmission facilities.

Implementing Action (a). Preserve existing water sources, supplies, and facilities for continued beneficial agricultural uses of surface and ground water.

Lead Organization: Legislature
Assisting Organization: DLNR, DOA
Time Frame: FY 1981-87
Budget Estimate: None
Priority: Medium

Implementing Action (b). Provide funds to plan and construct irrigation water systems in support of agricultural parks, including in particular those located at Pahoa, Panaewa, Ke'ahole, and Lalamilo, on the island of Hawaii; Waimanalo, Waianae, and Kahuku on Oahu; Kula on Maui; and Kilauea on Kauai.

Lead Organization: Legislature
Assisting Organization: DLNR, DOA
Time Frame: FY 1981-87
Budget Estimate: $7,745,000 (See Appendix C)
Priority Relative to Other Implementing Actions: High

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (c). Evaluate the need for new, expanded, or improved State irrigation systems outside of agricultural parks, and develop as needed.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: FY 1981-87
Budget Estimate: Additional funds required beyond $8.2 million for agricultural park water systems development.
Priority Relative to Other Implementing Actions: High

Policy 2. Encourage close collaboration among agencies concerned with agricultural land planning and water development. 7(b)(6)

Implementing Action (a). Coordinate the activities of concerned federal, state, and county agencies to assure that agricultural water requirements and priorities are fully considered in planning and development decisions.

Lead Organization: DLNR
Assisting Organization: DPED, DOA
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: High

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (b). Subsidize county municipal water systems serving agricultural water where there are no agricultural water systems.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Additional Funds Required
Priority Relative to Other Implementing Actions: Medium

Policy 3. Encourage the continued assessment of potential sources for development of agricultural water supplies. — 7(b)(6)

Implementing Action (a). Continue to assess potential sources for development of agricultural water supplies, with particular emphasis upon sources suitably located for transmission of water by gravity flow to croplands.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Policy 4. Promote the increased efficiency in the storage, transmission, and application of irrigation water. — 103(h)(4)

Implementing Action (a). Support directed research to increase watershed yields, reduce costs of pumping and storage, and perfect irrigation application methods.

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Lead Organization: UH Assisting Organization: DLNR, DOA Time Frame: FY 1981-87 Budget Estimate: $50,000/FY Priority Relative to Other Implementing Actions: Medium	
Implementing Action (b). Review reasonableness of rates charged for water sold under state water licenses. Lead Organization: DLNR Assisting Organization: DOA Time Frame: FY 1981-87 Budget Estimate: $35,000 Priority Relative to Other Implementing Actions: Medium	
Objective G. INCREASE THE USE OF TREATED SEWAGE EFFLUENT AND OTHER NONPOTABLE WATER FOR IRRIGATION PURPOSES.	103(h)(2)
Policy 1. Encourage siting of wastewater treatment plants so that effluent can be feasibly recycled for crop irrigation.	103(h)(2)
Implementing Action (a). Require that site planning for wastewater plants give consideration to the proximity of irrigated or irrigable cropland to permit the feasible reuse of effluent for irrigation purposes. Lead Organization: County Depts. of Public Works Assisting Organization: DOA, DLNR Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 2. Provide appropriate incentives to encourage the use of treated wastewater for irrigation purposes.	103(h)(2)
Implementing Action (a). Consider property or excise tax incentives to irrigation water users who reuse wastewater. Lead Organization: Taxation Dept. Assisting Organization: DLNR Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Low	
Policy 3. Promote research to establish the economic feasibility and safety of reusing wastewater and other nonpotable water for irrigating crops such as sugarcane and forage.	16(b)(2) 16(b)(3)
Implementing Action (a). Support research to investigate the technical and economic feasibility of using wastewater or brackish water for irrigation applications notably those employing the drip method. Lead Organization: UH Assisting Organization: DLNR, DOA Time Frame: Ongoing Budget Estimate: $50,000/FY Priority Relative to Other Implementing Actions: Medium	
Implementing Action (b). Promote the use of brackish water instead of fresh water for landscape and golf course irrigation and similar applications. Lead Organization: DLNR Assisting Organization: All Water Agencies Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Objective H. PROMOTE AGRICULTURAL WATER CONSERVATION.	16(b)(6)
Policy 1. Promote conservation of agricultural water to assure a safe and dependable water supply for all purposes.	16(b)(6)
Implementing Action (a). Develop cooperative programs with agricultural research agencies to explore and implement feasible conservation practices.	
Lead Organization: DLNR Assisting Organization: DOA Time Frame: FY 1981-87 Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	
Implementing Action (b). Consider incorporating water conservation provisions in all new state water licenses.	
Lead Organization: DLNR Assisting Organization: Attorney General Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	
Policy 2. Encourage activities to reduce or eliminate agricultural water losses, such as conversion to more efficient irrigation methods, and the rehabilitation of unlined, leaky ditches or substitution of closed pipelines.	103(h)(4)
Implementing Action (a). Require that approved conservation programs be a condition of state grants and loans for irrigation systems.	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Require, where practicable, the use of more efficient irrigation methods in state-sponsored agricultural parks.

Lead Organization: DLNR
Assisting Organization: DOA
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Objective I. PROVIDE ADEQUATE, REASONABLY PRICED WATER SUPPLIES FOR AGRICULTURAL PRODUCTION. 103(d)(11)

Policy 1. Encourage county municipal water systems to continue to charge lower rates for agricultural water consumers. 103(d)(11)

Implementing Action (a). Where the county municipal water system is the only alternative available for diversified crop irrigation, require the equitable accommodation of agricultural water needs as a condition of State grants and loans for municipal water projects.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 2. Continue the public subsidy of irrigation water projects to enhance their feasibility.	103(d)(11)
Implementing Action (a). Maintain the present water rates charged by state-operated irrigation systems, or reduce rates where necessary to sustain economic diversified crop production. Lead Organization: Legislature Assisting Organization: DLNR Time Frame: Ongoing Budget Estimate: May Require Additional Funds Priority Relative to Other Implementing Actions: High	

SELF-SUPPLIED INDUSTRIAL WATER

Objective J.	REDUCE THE ENVIRONMENTAL IMPACT OF WASTE HEAT DISPOSAL FROM THERMOELECTRIC POWER PLANTS.	13(b)(3)
Policy 1.	Promote research to develop more effective disposal of the large quantities of waste heat discharged from thermoelectric cooling systems.	15(b)(3)
Implementing Action (a). Encourage applied research to determine the effect of cooling water discharges on the Hawaiian ocean environment, including the potential of enhancing populations of aquatic life for sport or commercial fishery. Lead Organization: UH Assisting Organization: DLNR Time Frame: Ongoing Budget Estimate: $50,000/FY Priority Relative to Other Implementing Actions: Medium		

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 2. Encourage studies of alternative sites for thermoelectric power plants and the potential effects upon the community and other land and water uses.	13(b)(3) 15(b)(3)
Implementing Action (a). Cooperate with efforts to investigate alternative sites for thermoelectric power plant sites statewide. Lead Organization: DPED Assisting Organization: DLNR Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	
Objective K. DEVELOP WATER SOURCES FOR THE GENERATION OF HYDROELECTRIC POWER.	18(b)(1) 18(b)(6)
Policy 1. Encourage the continued assessment of sites well suited for commercial hydrolectric power plants, and encourage joint public and private financing of hydroelectric power development in Hawaii.	18(b)(1)
Implementing Action (a). Support programs for hydroelectric power development. Lead Organization: DPED Assisting Organization: DLNR, County Water Agencies Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 2. Promote the integration of thermoelectric and hydroelectric power plants to improve efficiency.	18 (a) (1)
Implementing Action (a). Collaborate with public utilities to assess and plan for the integration of new hydroelectric power plants with existing thermoelectric plants for increased efficiency. Lead Organization: DPED Assisting Organization: DLNR, County Water Agencies Time Frame: Ongoing Budget Estimate: $50,000/FY Priority Relative to Other Implementing Actions: Medium	
INSTREAM USES OF WATER	
Objective L. ESTABLISH A PROGRAM FOR INSTREAM FLOW MANAGEMENT AND DEVELOP INSTREAM FLOW STANDARDS.	11 (b) (2)
Policy 1. Promote the inventory of significant ecological, aesthetic, and recreation values for the development of instream flow standards.	11 (b) (2)
Implementing Action (a). Designate a state agency responsible for data collection, inventory of instream values, and for the development of instream flow standards. Lead Organization: Legislature Assisting Organization: DLNR, DOH Time Frame: FY 1981-82 Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: High	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (b). Compile and inventory all pertinent data for development of interim instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $70,000
Priority Relative to Other Implementing Actions: High

Implementing Action (c). Develop interim instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $30,000
Priority Relative to Other Implementing Actions: High

Policy 2. Promote the public interest in instream ecological, aesthetic, and recreation values, considering economic values. 13(b)(1)

Implementing Action (a). Take appropriate measures to protect and preserve unique ecosystem, waterfalls, scenic streams, rivers, lakes, and reservoirs.

Lead Organization: DLNR
Assisting Organization: DPED, County Water agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: High

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (b). Provide and maintain, where appropriate, access for viewing and onsite enjoyment of scenic sites.

Lead Organization: DLNR
Assisting Organization: DPED, Counties
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Implementing Action (c). Develop instream flow standards, stream by stream, to protect ecological, aesthetic, and recreational values.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Implementing Action (d). Prepare draft legislation for instream flow standards.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $15,000
Priority Relative to Other Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

WATER FOR AQUACULTURE

Objective M. DEVELOP WATER SUPPLIES FOR AQUACULTURE. 103(d)(2)

Policy 1. Encourage further assessment of sites well suited for commercial aquaculture and promote the planning and development of water supplies for such sites. 103(d)(2)

Implementing Action (a). Provide for aquaculture land use and water needs in state and county planning and development decisions.

Lead Organization: DLNR
Assisting Organization: County Planning Agencies
Time Frame: FY 1981-87
Budget Estimate: May Require Additional Funds
Priority Relative to Other Implementing Actions: Medium

Implementing Action (b). Establish cooperative research programs to define water requirements for aquaculture.

Lead Organization: DLNR
Assisting Organization: UH
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Medium

Policy 2. Encourage cooperation between public planning agencies and private interests to insure that state support of aquaculture, including water development, is responsive to industry needs. 10(b)(1)

Implementing Action (a). Conduct studies to determine adequacy of water sources to support aquaculture at potential sites.

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Investigate the feasibility of reclaiming livestock waste for aquaculture and recycling aquacultural wastewater for crop irrigation.

Lead Organization: DLNR
Assisting Organization: UH, DOA
Time Frame: FY 1981-87
Budget Estimate: $25,000/FY
Priority Relative to Other
Implementing Actions: Medium

Policy 3. Support research to determine water requirements for aquaculture and feasible disposal methods for aquacultural effluent. — 10(b)(1)

Implementing Action (a). Provide for systems to effectively eliminate contamination and utilize wastewater from aquaculture farms.

Lead Organization: DLNR
Assisting Organization: UH, DOH
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other
Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

WATER RESOURCES MANAGEMENT

Objective N. ENUNCIATE BASIC STATE WATER RESOURCES POLICY AND IMPROVE ADMINISTRATIVE FRAMEWORK. — 11(b)(5), 13(b)(2), 13(b)(3), 13(b)(8)

Policy 1. Improve the administrative framework for water resources management by providing a sound legal basis for government management and regulation of water resources, while safeguarding private water rights. — 13(b)(2), 13(b)(3)

Implementing Action (a). Authorize the formulation of a state water code aimed at defining the role of the state government in water resources management, specifying statutory language on water rights, and providing for an improved administrative structure.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: 3 years
Budget Estimate: $100,000 per year
Priority Relative to Other Implementing Actions: High

Objective O. PROVIDE FOR WATER USE CONTROL. — 13(b)(3)

Policy 1. Manage the water resources of the state for the most beneficial use by present and future generations. — 13(b)(2)

Implementing Action (a). Implement the Ground Water Use Act when necessary to regulate the utilization of ground water sources in critical areas.

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: DLNR
Assisting Organization: -
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: High

Policy 2. Assure equitable water use control of water sources for the good of the people. — 13(b)(3), 13(b)(8)

Implementing Action (a). Institute a program to register all water source utilization in the state as an initial step in the assessment of water supplies presently and potentially available.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $40,000
Priority Relative to Other
Implementing Actions: High

Implementing Action (b). Enact legislation providing for the administrative regulation of all development and use of water resources in the state.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-83
Budget Estimate:
Priority Relative to Other
Implementing Actions: High

	Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Objective P.	MINIMIZE STORM WATER DAMAGE.	13(b)(5)
Policy 1.	Reduce loss of life and property damage caused by storm flooding, tsunami, and high surf.	13(b)(5)
	Implementing Action (a). Provide cost-effective structural measures such as dams, lined channels, and flood proofing. Lead Organization: County Depts. of Public Works Assisting Organization: DLNR, SWCD Time Frame: Ongoing Budget Estimate: May Require Additional Funds Priority Relative to Other Implementing Actions: Medium	
	Implementing Action (b). Control coastal development in areas subject to tsunami and high surf. Lead Organization: DLNR Assisting Organization: DPED, County Planning Agencies Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	
Policy 2.	Enhance flood forecasting and monitoring.	13(b)(5)
	Implementing Action (a). Enhance warning systems to detect storm conditions likely to cause flash flooding. Lead Organization: County Civil Defense Agencies Assisting Organization: - Time Frame: Ongoing Budget Estimate: May Require Additional Funds Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 3. Provide flood insurance protection to existing residences located in flood plains.	13(b)(5)
Implementing Action (a). Provide nonstructural measures such as flood plain and zoning regulations, building codes, and flood insurance. Lead Organization: County Planning Agencies Assisting Organization: DLNR, SWCD Time Frame: Ongoing Budget Estimate: May Require Additional Funds Priority Relative to Other Implementing Actions: Medium	
Policy 4. Intensify flood plain management activities to reduce future flood damage and to reduce future costs for protective measures.	13(b)(5)
Implementing Action (a). Promote educational programs. Lead Organization: DLNR Assisting Organization: SWCD, County Planning Agencies Time Frame: Ongoing Budget Estimate: $20,000/FY Priority Relative to Other Implementing Actions: Medium	
Policy 5. Ensure the safety of dams to reduce downstream flood hazards.	13(b)(5)
Implementing Action (a). Determine dam safety hazards by field inspection and analysis, and take corrective action to minimize hazards. Lead Organization: DLNR Assisting Organization: Corps of Engineers Time Frame: Ongoing Budget Estimate: Additional Funds Required Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (b). Prepare draft legislation to regulate the design, construction, maintenance, and operation of dams and reservoirs in Hawaii.

Lead Organization: DLNR
Assisting Organization: Corps of Engineers
Time Frame: FY 1981-87
Budget Estimate: $50,000
Priority Relative to Other Implementing Actions: Medium

Objective Q. PREVENT CONTAMINATION OF SOURCES OF WATER SUPPLY. — 13(b)(2), 13(b)(3)

Policy 1. Manage surface drainage areas and ground water aquifers to prevent contamination of sources of water supply. — 13(b)(2)

Implementing Action (a). Solicit federal funds for planning and construction of water treatment facilities to meet quality standards for drinking water.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: (Federal Funds)
Priority Relative to Other Implementing Actions: Medium

Implementing Action (b). Allow solid waste disposal only where leachates will not pose a hazard to existing or potential sources of potable ground water.

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: High

Implementing Action (c). Allow subsurface or injection well disposal of sewage or industrial wastes only where it will not pose a hazard to existing or potential sources of potable ground water.

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (d). Control well spacing and pumping to optimize development of sensitive basal aquifers.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: High

Implementing Action (e). Control use of high-chloride or or other poor quality irrigation water in areas overlying good quality ground water reservoirs.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: High

Implementing Action (f). Support and help implement the erosion and sediment control measures of the State's "208" planning program relating to management of non-point source pollution.

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: Dept. of Health
Assisting Organization: DLNR
Time Frame: Ongoing
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Policy 2. Encourage research to improve means of monitoring and testing water supplies to prevent contamination. — 13(b)(3)

Implementing Action (a). Investigate water treatment and monitoring techniques that will minimize the cost of complying with state and federal drinking water standards.

Lead Organization: Dept. of Health
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/FY
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). Increase basal lens monitoring to prevent salt water intrusion.

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $50,000/Fy
Priority Relative to Other
Implementing Actions: High

Objective R. ENHANCE MANAGEMENT OF WATERSHEDS. — 11(b)(5), 13(b)(2)

Policy 1. Continue to manage state forest lands to protect and improve the condition of soils and vegetative cover so as to retard rapid runoff of storm flows, prevent soil erosion, and help sustain water yields of the quality and quantity needed. — 13(b)(2)

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (a). Conduct a systematic field survey of those state forest lands needing erosion control treatment.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: FY 1981-87
Budget Estimate: $20,000/FY
Priority Relative to Other Implementing Actions: High

Implementing Action (b). Install watershed rehabilitation measures to stabilize eroded areas, and to control erosion on roads and trails on state forest lands.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: FY 1981-87
Budget Estimate: $100,000/FY
Priority Relative to Other Implementing Actions: High

Policy 2. Promote sound watershed protection and management practices in all forests in all land use districts, both publicly and privately owned. — 13(b)(2)

Implementing Action (a). Continue to maintain close working relationships among agencies, organizations, and individuals concerned with the management, protection, and use of the State's watershed, and share research knowledge and expertise to promote sound watershed management practices.

Lead Organization: DLNR
Assisting Organization: U.S. Soil Conservation Service
Time Frame: Ongoing
Budget Estimate: May Require Additional Funds
Priority Relative to Other Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Policy 3. Carry out a continuing program of watershed management, rehabilitation, and protection, including the application of new methods and practices as they are developed and proven.	13(b)(2)
Implementing Action (a). Plan and carry out intensified rainfall-soil-vegetation surveys to provide basic information for resource protection and management and to determine whether present watershed boundaries need to be revised to better protect watersheds and water supplies.	
Lead Organization: DLNR Assisting Organization: U.S. Soil Conservation Service Time Frame: FY 1981-87 Budget Estimate: $20,000/FY Priority Relative to Other Implementing Actions: Medium	
WATER INFORMATION NEEDS	
Objective S. EXPAND RESEARCH PROGRAMS.	13(b)(2) 13(b)(3) 16(b)(2)
Policy 1. Encourage research and monitoring programs for water data development for effective water resources planning and management.	13(b)(2)
Implementing Action (a). Continue to support the presently diversified water resource research effort (i.e., mission agency research and grant agency research).	
Lead Organization: DLNR Assisting Organization: UH Time Frame: Ongoing Budget Estimate: $30,000/FY Priority Relative to Other Implementing Actions: Medium	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Implementing Action (b). Develop a closer tie between planning and research in order to assure continued success and reinforce the value and relevance of each. Lead Organization: DLNR Assisting Organization: UH Time Frame: Ongoing Budget Estimate: Not Applicable Priority Relative to Other Implementing Actions: Medium	
Objective T. IMPROVE DATA COLLECTION, ANALYSIS AND DISSEMINATION PROGRAM.	13(b)(2)
Policy 1. Encourage establishment of a good basic water data program by improvement of data collection, analysis and dissemination.	13(b)(2)
Implementing Action (a). Accelerate and improve programs for gathering information on water resources, including potential yields, water conservation opportunities, water demands, methods and costs of water development, and environmental impacts of development. Lead Organization: DLNR Assisting Organization: County Water Agencies Time Frame: Ongoing Budget Estimate: $50,000/FY Priority Relative to Other Implementing Actions: High	
Implementing Action (b). Improve means of putting available information to effective use in water management.	

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Lead Organization: DLNR
Assisting Organization: County Water Agencies
Time Frame: Ongoing
Budget Estimate: $20,000/FY
Priority Relative to Other
Implementing Actions: Medium

FINANCING WATER PROGRAMS & PROJECTS

Objective U. IMPROVE STATE GRANT AND LOAN PROCEDURES FOR WATER PROGRAMS AND PROJECTS. — 28(a) 104(c)(3)

Policy 1. Provide basis for orderly authorization and financing of water programs and projects. — 28(a)

Implementing Action (a). Utilize the policies and procedures of this Functional Plan to identify, set priorities for, and guide legislative funding for all meritorious water programs and projects.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other
Implementing Actions: Medium

Implementing Action (b). In providing State grants and loans to Counties, give priority to support of municipal water projects and systems designed and operated to accommodate agricultural, as well as residential, water uses and needs.

Lead Organization: DLNR
Assisting Organization: Counties
Time Frame: Ongoing
Budget Estimate: Additional funds required
Priority Relating to Other
Implementing Actions: High

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan
Objective V. DEVELOP ADDITIONAL WATER FINANCING PROGRAMS.	28(a)
Policy 1. Continue to determine alternative methods of financing future water resources developments.	28(a)

Implementing Action (a). Explore the feasibility of purchasing bonds with state funds in order to reduce county borrowing costs and state grants for municipal water systems.

Lead Organization: Legislature
Assisting Organization: Dept. of Budget & Finance
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Low

Implementing Action (b). Explore cost-sharing between the state and counties as a means of encouraging selection of the more efficient water programs and projects and requiring beneficiaries to share in the costs.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Medium

Implementing Action (c). Require institution of appropriate water conservation programs by the counties as a condition of grants and loans for municipal water supply and wastewater facilities.

Lead Organization: Legislature
Assisting Organization: DLNR
Time Frame: FY 1981-87
Budget Estimate: Not Applicable
Priority Relative to Other Implementing Actions: Medium

Functional Plan Objectives, Policies, and Implementing Actions	Corresponding Provision of Hawaii State Plan

Implementing Action (d). Bolster applied water research in the state through long-term contributions from those state and county agencies that stand to benefit.

Lead Organization: WRRC
Assisting Organization: All Water Agencies
Time Frame: FY 1981-87
Budget Estimate: $50,000/FY
Priority Relative to Other Implementing Actions: Low

CHAPTER V

COORDINATION

V. COORDINATION WITH OTHER STATE AND COUNTY PLANS AND PROGRAMS

Planning for water resources development under Hawaii State Plan guidelines is necessarily general and long-range in its outlook. It provides an overview to which implementing agencies and organizations can relate their specific planning and development activities. The successful implementation of the State Water Resources Development Plan will, in large measure, depend upon the degree of review and coordination that is afforded across the broad spectrum of State, County, and Federal Programs. The State's Department of Planning and Economic Development, administering agency for all functional planning, will continue to coordinate planning for water resources development with other planning activities.

A. COORDINATION AMONG PLANS

The following planning efforts bear a direct relationship to the State Water Resources Development Plan and will require the continuing integration of their policies and implementation programs with those of the Water Resources Development Plan.

Hawaii State Plan. Chapter 226, Hawaii Revised Statutes, calls for the preparation of State functional plans for selected functional areas, including water resources development, to define, implement, and be in conformance with the overall theme, goals, objectives, policies, and priority directions contained in the Hawaii State Plan. The State functional plans provide the critical middle link between the general policies of the Hawaii State Plan and specific programs and actions to be carried out by the various State agencies. Therefore, correlation of the Water Resources Development Plan with the Hawaii State Plan is essential.

State Water Commission Report. Specific recommendations presented in the recent report of the ad hoc State Water Commission provide guidance for management of the water resources of the State. Many of the Commission's recommendations have been adopted in this Water Resources Functional Plan.

Hawaii Water Resources Plan. The primary focus of the Hawaii Water Resources Plan, a joint Federal-State-County planning effort, is comprehensive region-wide water resources planning. Dealing with the multiple use of all water and related land resources, the plan provides a reconnaissance level framework for more specific project and program planning. In particular, the development potential of inland water resources have been identified and are expanded upon in formulating the action programs and projects contained in this Water Resources Functional Plan.

Other State Functional Plans. Areas requiring coordinative action between the Water Resources Functional Plan and the other functional plans are discussed in the subsequent sections.

County Water Plans. The water development plans of the Boards of Water Supply of the respective Counties are reflected in this Water Resources Functional Plan to assure continued integration of county action programs related to water development. Cooperation is needed to achieve objectives identified by planning areas where implementation would satisfy regional or statewide needs as well as local needs.

County General Plans and Development Plans. Because statewide planning for water resources development would in many places impact upon County jurisdiction, close coordination must be achieved so that County general and development plans can serve as the bases for specific State programs and projects in those areas.

B. COMPLEMENTARY ACTIONS

Actions of a complementary nature will involve programs and projects relating to: (1) water quality enhancement, which are implemented by the State Department of Health; (2) water resources research, implemented by the University of Hawaii; (3) water data collection, implemented jointly by various public agencies and private cooperators; (4) watershed protection, implemented by the State Department of Land and Natural Resources in conjunction with the U.S. Forest Service; (5) fish and wildlife protection, implemented by the State Department of Land and Natural Resources; (6) flood management, implemented jointly among Federal, State, and County agencies; and (7) environmental protection, implemented by the State Office of Environmental Quality Control.

The plans and programs of the County Boards of Water Supply relative to municipal water development are complementary in nature and are essential components of this Water Resources Functional Plan.

Among State functional plans, direct complementary interaction will occur between the water resources functional plans and the functional plans for agriculture, tourism, public health (environmental concerns), conservation lands, and recreation.

C. CONFLICTING ACTIONS

Power over water resources development is divided among several agencies. The diffusion sometimes creates jurisdictional conflicts and cloudy policies, but in general the coordination has been good. This favorable state of affairs can be attributed largely to the availability of water in sufficient quantities to satisfy the diversity of needs. Recent assessments of the water situation in Hawaii by the ad hoc State Water Commission, the U.S. Water Resources Council (Second National Water Assessment), and the Hawaii Water Resources Regional Study point to the

growing competition among users and the periodic local shortages of water despite the general adequacy of supplies statewide or islandwide. Problems of dwindling surface water supplies and ground water overdraft are becoming serious in certain areas, and jurisdiction conflicts in managing the limited resource are bound to become correspondingly more difficult to resolve.

The preceding sections of the report detail those areas--such as water use regulation, water development responsibilities, project financing, storm water control, and maintenance of water quality--where the administrative policies at the State level may not always be consistent with the corresponding policies at the County level, particularly those program areas where policies differ among the counties themselves. For example, the regulation of water use on Oahu, unlike on the neighboring islands, may in one situation come under the purview of the Board of Water Supply of the City and County of Honolulu and in another situation come under the jurisdiction of the State Board of Land and Natural Resources. This program is heightened by the recently adopted provision of the State Constitution that calls for the centralization of water use regulatory powers in a single agency.

The general relationships between the Water Resources Function 1 Plan and other functional plans have been discussed in Chapter II. Major impacts of the Water Resources Functional Plans are identified below:

State Housing Plan. The availability of a good quality water supply is a major criterion on the use of urban lands for housing development. It seems certain that population growth, increasing per capita use, and expanding economic activity will strain many of the existing county municipal systems. In the more water-scarce and rapidly growing areas--in the Pearl Harbor area, for example--competition for supplies will mount. While the Water Resources Development Plan urges

the orderly construction of facilities to keep up with growing water demands in urban areas, it also encourages the preservation of the resources for environmental and social purposes and the accommodation of agricultural water demands. Such competition for the water resource can be resolved through careful planning, but ultimately must involve some systematic means of governmental allocation of the dwindling resource among the various uses of water. Statewide regulation of the water development and use, absent so far except in special circumstances, is being proposed under this State Water Resources Development Plan. Because water supply for housing is essentially an urban problem, much hinges on how well water facility planning meshes with land use planning. Close coordination has been maintained between the state and county water agencies in planning for municipal water supplies, resulting in the continuing infusion of State grants-in-aid to counties for domestic water facilities. This is largely reflective of the State's position that though the State subscribes to the beneficiary-pay principle relative to water facility financing, it justifies subsidies when compelling social purposes are served, such as the provision of public housing.

State Energy Plan. The implementation of hydropower projects to help meet statewide energy needs would result in varying impacts on the water resource environment, depending on the location of the project, the mode of power development, and other factors. A hydropower project could result in dewatered streams or could contibute to reduced but more stable streamflows. Resulting reservoirs can provide significant fishing and water sport areas. Nonetheless, unknowns exist and caution must be exercised before proceeding with any hydropower project. Unknown impacts include (1) effects of dams that preclude upstream fish migration, (2) effects of altered streamflows on stream ecosystems, and (3) impingement on existing water rights.

State Agricultural Plan. Development of public irrigation water systems has historically been a function of the State government and has rested with the Department of Land and Natural Resources. Associated with the renewed interest toward farm development throughout the State is the delineation of responsibilities between the Department of Agriculture and the Department of Land and Natural Resources. So that the agricultural park program of the Department of Agriculture can be facilitated relative to land and water facility development, both departments are working on a memorandum of understanding that prescribes the division of responsibilities. This memorandum is a significant step in coordinating the related activities of the two agencies. While complementary effort can be exercised in many areas, such as developing new water sources, determining crop water requirements, promoting irrigation efficiencies, utilizing wastewaters, and financing irrigation works, conflict can arise in ensuring that sufficient water supplies are made available for agriculture. There is always the possibility that available resources would not be sufficient to satisfy all water uses. Where such a situation arises in the future it is hoped that new water allocation legislation would have been enacted to better cope with the problem. The Water Resources Development Plan is proposing the introduction of appropriate legislation.

State Health Plan. The maintenance of desirable fish and wildlife populations and the preservation of natural beauty require water of good quality. The demand for water-based recreation is increasing and also requires clean water. The surface and ground water sources of water supply need to be protected from quality degradation. The objectives and policies of the Water Resources Development Plan and the Health Plan are supportive of each other in these areas. To the extent

that existing wastewater systems which could possibly contaminate water sources are allowed to remain poses some threat to the continued availability of safe water supplies. Further, compliance with the State Safe Drinking Water statute will require significant county expenditures for construction of water treatment plants. The economic impact on county water departments may be unmanageable without assistance from the Federal and State governments. The Water Resources Development Plan calls for State financial aid to counties for water treatment projects.

State Transportation Plan. It is technically feasible and can make good economic sense to transfer water now utilized for irrigation to municipal use in exchange for treated sewage effluent. It is also desirable in water-short areas to utilize lower quality caprock water for landscaping purposes so that potable quality water now applied for irrigation can be reserved for municipal uses. Both concepts, in addition to conservation measures, are being considered in highway transportation planning and when implemented will result in mutual benefits to both water developing and water using agencies. Where transportation planning involves highway routings through water-bearing mountain ranges--the proposed trans-Koolau highway, for example--impacts of tunneling on water tables should be carefully studied.

Conservation Lands Plan. The implementing of recommended actions under the Water Resources Development Plan and the Conservation Lands Plan is primarily the responsibility of the Department of Land and Natural Resources. This allows for improved correlation of activities related to watershed management and flood hazard mitigation.

Recreation Plan. Many opportunities exist for enhancing the environment by innovative use of water, such as aesthetic enhancement of ponds and streams, and recreational use of streams, reservoirs, and even flood plains. Again, because most state water resources development and recreation programs are carried out within one department, the opportunity exists for a coordinated approach to plan implementation.

Education Plan. The Education Plan calls for a continued emphasis on the Department of Education's environmental education program, including its focus on the wise use of land resources and the conservation of water. The continued development of this program will require on-going consultation of DOE curriculum specialists with the staff of the Department of Land and Natural Resources to ensure that information needs are adequately met.

Historic Preservation Plan. There is a need for the Water Resources Development Plan to accommodate the maintenance of water supplies of adequate quality to sustain water-related historic properties such as fishponds, taro plots, etc. The Historic Preservation Plan identifies three points of relationship with the Water Resources Development Plan: (1) pre-construction archaeological surveys required for all water project areas, (2) legal protection of known sites and protection of resources discovered in the course of construction of water facilities, and (3) restoration and maintenance of resources at water project sites to enhance their value.

Higher Education. Current research conducted by the University of Hawaii is supportive of the types of effort encouraged in the Water Resources Development Plan. The increasing complexity of water management will call for a higher level of capability to be provided in graduates in technological areas and in interdisciplinary understanding.

Tourism Plan. The Tourism Plan recognizes that the pace and location of hotel industry growth, as well as the growth of many economic activities directly or indirectly dependent on tourism, hinge greatly on the adequacy of infrastructural requirements, notably water supply facilities. The development of resort destination areas would suffer if water facility funding is delayed or if limited water supplies are channeled to other, perhaps more preferential, uses. Water for tourism is not unlike water for housing, and in certain locations both could face stiff competition from agriculture and the environment when allocation decisions must be made in strict interpretation of the Priority Directions. In this Plan, water needs for tourism are accommodated in conjunction with the satisfaction of the broader needs for municipal water. Here, the projections of water requirements for the tourist industry are a part of the projections for total municipal water requirements, and facilities to service tourism needs comprise a significant portion of the capital improvements budget of the county boards of water supply. An objective of the State Water Resources Development Plan is the "assurance of adequate municipal supplies for planned urban growth", and the Plan urges the continued financial support of the counties in carrying out their needed municipal water projects.

As implementation progresses, this functional plan will have to accommodate any changing relationships with other functional plans of the State and Counties. Through continuing collaboration in the review and update of the plans, compatible public policies for water resources development can be formulated. It is at this level of resource planning that competing environmental, social, and economic demands for water resources development can be effectively reconciled.

APPENDICES

Appendix A
CAPITAL PROGRAMS AND PROJECTS
(As Proposed Under State Programs)

(Unit: $1000)

Project	Biennium FY 1981-82	FY 1982-83	FY 1983-87
1. MUNICIPAL WATER (See Appendix B for specific project)			
County of Hawaii	365	370	135
County of Maui	360	360	135
City & County of Honolulu	940	935	35
County of Kauai	365	365	35
Subtotal	2,030	2,030	340
2. AGRICULTURAL WATER (See also Appendix C)			
Statewide:			
Lalamilo (Puu Pulehu Reservoir)	1,000	--	--
Waimanalo Agricultural Park Water System	165	2,295	985
Kahuku Agricultural Park Water System	--	--	1,425
Other projects	60	450	1,365
Subtotal	1,225	2,745	3,775
3. INDUSTRIAL WATER			
Statewide:			
Hydropower Development	50	50	900
4. AQUACULTURE			
Statewide:			
Water Development for Aquaculture	50	50	1,000
5. WATER MANAGEMENT			
Statewide:			
Development of Instream Use Program	70	70	160
Ground Water Monitoring	600	600	700
Subtotal	670	670	860
Total	4,025	5,545	6,875

Appendix B
SUGGESTED MUNICIPAL WATER PROJECTS
(As Submitted by Counties)

(Unit: $1000)

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
	COUNTY OF HAWAII				
	Source Development				
1	Exploratory Wells, N. Kona	500	500		
2	Exploratory Wells, S. Kona	300	300		
3	Kahaluu Shaft Source, pump additions	200	200	200	
4	Lalamilo Source Development	400	400	200	
5	Source Development, N. Kona	200	200	1,600	
6	Olaa Spring-Waiakea Spring-Mt. View Source & Transmission	100	1,000	1,900	
7	S. Kona Water System Dev. (Honomalino)	400	400		
8	Paukaa-Papaikou High Level Source Improvement	30	220		
9	Papaikou Deep Well No. 2	40	200	210	
10	High Level Source Investigation, Hamakua	50	50	200	
11	Kaauhuhu Source Improvement, N. Kohala	50	50	200	
12	Wailea-Hakalau Water System Development	500	500		
13	Pahala Surface Water Treatment Study			40	
14	Pahala Deep Well No. 2		30	370	
15	Waiaha Intake Study, N. Kona	40			
16	Glenwood Surface Source & Treatment Study		40		
17	Naalehu Deep Well No. 2			30	370
18	Keonepoko Nui Deep Well No. 2, Puna			30	370
19	Kukuihaele Booster Pump, Hamakua			80	
20	Keauohana Deep Well No. 3, Puna			30	370
	Storage Reservoir				
1	Third Storage Reservoir, S. Kohala	500	500	1,000	
2	Kihalani Reservoirs, N. Hilo	200	200		
3	Chong Man Reservoir, S. Hilo	50	500		
4	Piihonua Reservoir No. 2, S. Hilo	300	300		
5	DeLima Reservoir, S. Hilo	300	300		
6	Camp 7 Reservoir, S. Hilo	300	300		
7	Laaloa 0.3-MG Reservoir, N. Kona	40	410		

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
8	Keauhou 0.3-MG Reservoir, No. Kona	40	410		
9	Keonopoko Iki 0.3-MG Reservoir, Puna	250	250		
10	Kailua 1.0-MG Reservoir, N. Kona	300	400		
11	Palani 935' Elev. Reservoir, No. Kona	300			
12	Kaauhuhu Reservoir, N. Kohala	150	150		
13	Keokea Reservoir, S. Kona	20	180		
14	Kokoiki Reservoir, N. Kohala	30	270		
15	City of Refuge Reservoir, S. Kona	20	180		
16	Waipunalei 0.1-MG Reservoir, N. Hilo	20	180		
17	Honomu 0.1-MG Reservoir, S. Hilo			200	
18	Improvements to Existing Reservoirs (Olaa-Mt. View System), Puna	150	150		
19	Haao Holding Reservoir, Kau	500	500		
20	Replacing Four Redwood Tanks, Kau		300		
21	South Point Storage Reservoir, Kau	20	180		
22	Kaumana Reservoir No. 1, S. Hilo		30	370	
23	Kaumana Reservoir No. 1, S. Hilo		20	180	
24	Kawailani Reservoir, S. Hilo		40	560	
25	Kaieie Mauka Reservoir, S. Hilo			100	
26	Improvements to Existing Reservoirs (North & South Kona Water System)			50	350
27	Pohoiki 0.5-MG Reservoir, Puna				500
28	Additional Reservoir at Kalapana, Puna				400
	Transmission Main				
1	Pipeline Additions for Greater Capacity (Mamalahoa, N. Kona)	300	300		
2	S. Kona Water System Extension (Captain Cook-Napoopoo)	500	500		
3	Laupahoehoe-Papaaloa Pipeline, N. Hilo	200			
4	Makapala-Keokea Water System, N. Kohala	400			
5	Ahualoa-Kalopa Transmission, Hamakua	300	400		
6	Kokoiki Transmission, N. Kohala	100			
7	Watt Tunnel to Kaauhuhu, N. Kohala	50	450		
8	12-Inch Transmission - Keaau to Station No. 3, Puna	30	370		
9	Hoaka Road - Camp 7 to Camp 6 Transmission, S. Hilo	30	420		
10	Kaumana-Waiakea Uka Transmission, S. Hilo	70	930		

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
11	Pepeekeo-Papaikou Transmission, S. Hilo		60	540	
12	Haao to South Point Transmission, Kau		40	760	
13	Kaieie Mauka Transmission, S. Hilo		30	370	
14	Incremental Development of Transmission System, S. Hilo		100	100	2,250
15	Pahoa Bypass Waterline, Puna			250	
16	Hamakua Trunk Line Development, Hamakua		80	720	
17	Keaau-Pahoa Trunk Line, Puna			1,800	
18	Kalapana-Kaimu-Makena Homesteads, Puna			120	
19	Incremental Development of Water Sys., Kau		100	900	2,000
20	Kehena Ditch Water Project, N. Kohala			2,000	
	New Support Facilities				
1	Mamalahoa Boosters, N. Kona	300	300		
2	Mamalahoa Boosters, S. Kona	100	200		
3	Haina Booster Pump, Hamakua	80			
4	Panaewa Booster No. 2, S. Hilo	100			
5	Camp 6 Booster Additions, S. Hilo	50	50		
6	Haihai Booster Additions, S. Hilo	50	50		
7	Piihonua Reservoir 3, Booster 2, S. Hilo		20	80	
8	Keonepoko Booster 2, Puna	50	50		
9	New Camp 7 Booster, S. Hilo	40	40		
10	Kihala Booster Pump Station, N. Hilo		50		
11	Puainako Booster, S. Hilo			150	
12	Waiakea Reservoir Booster, S. Hilo			150	
	Other Facilities				
1	Pipeline Replacement within State Subdivision, N. & S. Hilo	150	150		
2	Hilo Lab Facilities, S. Hilo			400	
3	New Kona Base Yard			250	
4	Engineering-Fiscal Complex, S. Hilo	500	500		
5	Master Meter Installations, Hawaii	100	100	300	
6	Supervisory Control - Pumps and Reservoirs, Hawaii	100	100	300	
7	Waimea Treatment Plant No. 2, S. Kohala			2,500	
8	Water Source Investigation and Development, Islandwide	500	500	3,000	
	TOTAL - County of Hawaii	9,980	15,628	23,820	6,260

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
	COUNTY OF MAUI				
	Maui-Molokai				
1	Water Treatment Plants	4,000	3,000		
	Central Maui				
2	Wailuku-Kahului Transmission Line	300	200		
12	Kamaole-Kihei Reservoir	400	350		
	Groundwater Source Development				
3	West Maui, 3 wells	150	105	600	
4	Central Maui, 4 wells	100	100	725	
13	Keanae, 1 well	140			
	West Kuiaha, Hamoa, Kupehe, Peahi, Hana, Kamalo - 1 well each			1,065	
	Haiku-Makawao				
5	Haiku Well Pumping Unit, 1.0 MG Tank, 12" Transmission Line	900	600		
7	Haiku Water Project	200	150	4,540	710
	Kahului Airport-Kuau-Paia				
6	Paia Tank & Transmission Line	900	600		
	Hana Highway Transmission Line			500	
	Upper/Lower Kula				
8	Omaopio Pump Control/Tank, 2 - 0.5 MG	500	400		
9	Omaopio Pump Stations - 3 pumps	150	100		
10	West Olinda Tank	250	150		
11	Makawao-Olinda Pump Station & System	200	100	7,160	
	Molokai Water Project				
14	Kalae Pump Station pump control	100			
	Kawela Pump Station & related improvements			700	
	Kupeke Pump Station & related improvements			800	
	Kawela-Kamalo Transmission Line			1,000	5,000

Funding Priority	Project	Biennium FY 1981-82	FY 1982-83	FY 1983-87	Beyond FY 1987
	East Maui				
15	Source Studies & Investigation	100			
	Hana				
	Hana Transmission Line			3,400	1,725
	TOTAL - County of Maui	8,390	5,855	20,490	7,435

CITY & COUNTY OF HONOLULU

	Facilities for Production of Water				
1	Kahaluu Well, 0.5 mgd	765			
2	Luluku Well, 1 mgd		554		
3	Kaluanui Wells, two 1.0 mgd	308	1,717		
4	Makaha Wells, two 0.5 mgd	394	1,741		
5	Iolekaa Well, 0.3 mgd	427			
6	Wailupe Well, 0.25 mgd	58	780		
7	Kuou Well, 0.5 mgd	339	1,745		
8	Heco Waiau Wells, 4 mgd	196	2,528		
9	Punaluu Well IV, 0.5 mgd	44	266		
10	Waianae Well, 1 mgd	109	1,664		
11	Waialae Nui Well, 0.4 mgd	156	601		
12	Kaipapau Well, 1 mgd	271	102	1,846	
13	Maakua Well, 0.5 mgd	222	101	1,818	
14	Kaaawa Well, 0.5 mgd	209	108	1,941	
15	Punaluu Wells V, five 1 mgd		201	2,514	
16	Kahana Well II, 0.5 mgd		278	1,658	
17	Kamoalii Well, 0.5 mgd		355	2,083	
18	Hakipuu Well, 0.5 mgd		230	1,489	
19	Kaaawa Well II, 0.5 mgd		240	1,067	
20	Laie Well, 1 mgd			2,015	
21	Wailele Well, 1 mgd			2,282	
22	Makaha Wells II, two 0.5 mgd			1,290	
23	Makaha Wells IV, two 0.5 mgd			1,326	

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
24	Makaha Wells V, two 0.5 mgd			532	
25	UH Manoa Well, 0.5 mgd			91	
26	Kawailoa Well, 0.25 mgd			339	
27	Waimea Well, 0.25 mgd			160	
28	Mokuleia Well, 1 mgd			352	
29	Manoa Well, 0.5 mgd			36	
30	Kahuawai Springs, 0.2 mgd			40	
31	Waimanalo Wells II, 0.3 mgd			36	
	Water Storage Facilities				
1	Kahana "300" Reservoir, 2 mgd		5,660		
	New Pipelines				
1	Kamehameha Hwy 30" main (Waihee-Waikane)	199	3,977		
2	Kam Hwy 20" Main (Punaluu-Hauula)		128	2,461	
3	Kam Hwy 30" Main (Waikane-Kaaawa)		183	7,239	
4	Kam & Kahekili Hwy 42" Main (Waihee-Kahaluu)		1,769	3,841	
5	Kam Hwy 16" Main (Hauula-Kaipapau)			736	
6	Kam Hwy 30" Main (Kaaawa-Punaluu)			8,351	
7	Kahekili & Likelike Hwy (Kahaluu-Kaneohe)			2,803	
8	Kam Hwy 12" Main (Kaipapau-Laie)			78	
	New Support Facilities				
1	Kalihi Corporation Yard, Phase II	1,800			
	TOTAL - City & County of Honolulu	5,497	24,928	48,424	

Funding Priority	Project	Biennium FY 1981-82	Biennium FY 1982-83	FY 1983-87	Beyond FY 1987
	COUNTY OF KAUAI				
	Kekaha-Waimea				
5	1.0 mg Pokii Ridge Tank	600			
31	12" Main, Kekaha Road			300	
13	12" Main, Menehune Road		700		
20	8" Main, Ala Wai Road		50		
17	12" & 8" Main, Kuhio Hwy		100		
21	8" Main, Pokole, Laau & Halepule Rd.		70		
32	Drill Waimea Valley #2			200	
	Hanapepe				
18	8" Main, Puolo, Hana & Iona Rd.		150		
	Kalaheo-Lawai-Omao				
6	12" Main, Lawai to Omao	500			
9	Drill Kalaheo Deepwell #2		350		
12	Drill Lawai Deepwell #2		300		
	Koloa-Poipu				
1	Drill Poipu Well #2	200			
8	Pump & Controls Poipu Well #2		300		
15	8" Main, Weliweli-Waikomo Roads		100		
16	12" Main, Poipu Road		150		
	Lihue				
2	Kilohana Wells F,G.H. & I	360			
30	Lihue-Hanamaulu Main			300	
26	1.0 mg Nawiliwili Tank			650	
27	1.0 mg Kalepa Tank			650	

Funding Priority	Project	Biennium FY 1981-82	FY 1982-83	FY 1983-87	Beyond FY 1987
	Kapaa				
3	Pump & Controls Makaleha Well	300			
11	Drill Wailua Homesteads Well #2		200		
14	8"Main, Puuopae & Opaekaa Roads		300		
23	1.0 mg Stable Tank			650	
24	1.0 mg Wailua Homesteads Tank			650	
25	Drill Nonou Well D			250	
	Anahola				
19	Replace Wooden Tank	25			
4	Drill Anahola Well	200			
10	Pump & Controls, Anahola Well	200			
29	0.5 mg Anahola Tank			350	
33	6" Main, Anahola Beach Road			100	
	Kilauea-Kalihiwai				
28	0.5 mg Kilauea Tank			350	
34	Replace Kilauea Deepwell Pump			100	
	Islandwide				
7	Amend Water General Plan	150			
22	Water Sources Investigation & Dev.			3,390	
35	Certified Laboratory			500	
	TOTAL - County of Kauai	2,335	2,770	8,440	

Appendix C
SUGGESTED AGRICULTURAL WATER PROJECTS

(Unit: $1000)

Priority	Project	Biennium FY 1981-82	FY 1982-83	FY 1983-87
	PROPOSED			
High	Lalamilo (Puu Pulehu Reservoir), Hawaii	1,000	--	--
High	Waimanalo Agr. Park Water System, Oahu	165	2,295	985
High	Kahuku Agr. Park Water System, Oahu	--	--	1,425
High	Other agr. water projects, statewide	60	450	1,365
	Total	1,225	2,745	3,775

COMPLETED OR ON-GOING

Lalamilo Irrigation System Improv., Hawaii
Panaewa Agr. Park, Hawaii
Pahoa Agr. Park, Hawaii
Keahole Agr. Park, Hawaii
Waiahole Agr. System, Oahu
Kula Water Sytem, Maui
Waimea Irrigation System, Kauai
Waianae Agr. Park Water System, Oahu